7/2

119
March
985

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ommon cathode or
ommon anode

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KITT scanner

he secret behind
hose robot eyes:
vhy they look as
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oush and pull

oth stages driven
ll the way:
power amplifier
n class A!

TTLs

74 SERIES

7400	0.30
7401	0.30
7402	0.30
7403	0.30
7404	0.36
7405	0.30
7406	0.40
7407	0.40
7408	0.30
7409	0.30
7410	0.30
7411	0.30
7412	0.30
7413	0.50
7414	0.70
7416	0.36
7417	0.40
7420	0.30
7421	0.60
7422	0.36
7423	0.36
7425	0.40
7426	0.40
7427	0.32
7428	0.43
7430	0.30
7432	0.36
7433	0.30
7437	0.30
7438	0.40
7439	0.40
7440	0.40
7441	0.90
7442A	0.70
7443A	1.00
7444	1.10
7445	1.00
7446A	1.00
7447A	1.00
7448	1.00
7450	0.36
7451	0.35
7453	0.38
7454	0.38
7460	0.55
7470	0.50
7472	0.45
7473	0.45
7474	0.50
7475	0.60
7476	0.45
7480	0.65
7481	1.80
7483A	1.05
7484A	1.25
7485	1.10
7486	0.42
7489	2.10
7490A	0.55
7491	0.70
7492A	0.70
7493A	0.55
7494	1.10
7495A	0.60
7496	0.80
7497	2.10
74100	1.90
74107	0.50
74109	0.75
74110	0.75
74111	0.55
74116	1.70
74118	1.10
74119	1.70
74120	1.00
74121	0.55
74122	0.70
74123	0.80
74125	0.65
74126	0.55
74128	0.55
74132	0.75
74136	0.70
74141	0.90
74142	2.50
74143	2.70
74144	2.70
74145	1.10
74147	1.70
74148	1.40
74150	1.75
74151A	0.70
74153	0.80
74154	1.40
74155	0.80
74156	0.90
74157	0.80
74159	1.75
74160	1.10
74161	0.80
74162	1.10
74163	1.10
74164	1.20
74165	1.10
74166	1.40
74167	4.00
74170	2.00
74172	4.20
74173	1.40
74174	1.10
74175	1.05
74176	1.00
74178	1.50
74179	1.50
74180	1.00
74181	3.40
74182	1.40
74184	1.80
74185A	1.80
74190	1.30
74191	1.30
74192	1.10
74193	1.15
74194	1.10
74195	0.80
74196	1.30
74197	1.10
74198	2.20
74199	2.20
74221	1.10
74251	1.00
74259	1.50
74265	0.80
74273	2.00
74276	1.40
74278	1.70
74279	0.90
74283	1.05
74285	3.20
74290	0.90
74293	0.90
74298	1.80
74351	2.00
74365A	0.80
74366A	0.80
74367A	0.80
74368A	0.70
74376	1.60
74390	1.10
74393	1.20
74490	1.10
74393	1.20
74490	1.40

74LS SERIES

74LS00	0.24
74LS01	0.24
74LS02	0.24
74LS03	0.24
74LS04	0.24
74LS05	0.24
74LS08	0.24
74LS09	0.24
74LS10	0.24
74LS11	0.24
74LS12	0.24
74LS13	0.34
74LS14	0.50
74LS15	0.24
74LS20	0.24
74LS21	0.24
74LS22	0.24
74LS24	0.50
74LS26	0.24
74LS27	0.24
74LS28	0.24
74LS30	0.24
74LS32	0.24
74LS33	0.24
74LS37	0.24
74LS38	0.24
74LS40	0.24
74LS42	0.50
74LS47	0.80
74LS48	0.90
74LS51	0.24
74LS54	0.24
74LS55	0.24
74LS73A	0.30
74LS74A	0.35
74LS75	0.45
74LS76A	0.36
74LS78	0.42
74LS83A	0.70
74LS85	0.75
74LS86	0.35
74LS90	0.48
74LS91	0.90
74LS92	0.35
74LS93	0.54
74LS95B	0.75
74LS96	0.90
74LS107	0.40
74LS109	0.40
74LS112	0.45
74LS113	0.45
74LS114	0.45
74LS122	0.70
74LS123	0.80
74LS124/629	1.40
74LS125	0.50
74LS126	0.50
74LS132	0.65
74LS133	0.50
74LS136	0.45
74LS138	0.55
74LS139	0.55
74LS145	0.95
74LS147	1.75
74LS148	1.40
74LS151	0.65
74LS152	2.00
74LS153	0.65
74LS154	1.60
74LS155	0.65
74LS156	0.65
74LS157	0.50
74LS158	0.65
74LS160A	0.75
74LS161A	0.75
74LS162A	0.75
74LS163A	0.75
74LS164	0.75
74LS165A	1.30
74LS166A	1.50
74LS168	1.30
74LS169	1.00
74LS170	1.40
74LS173A	1.00
74LS174	0.75
74LS175	0.75
74LS181	2.00
74LS183	1.90
74LS190	0.75
74LS191	0.75
74LS192	0.80
74LS193	0.90
74LS194A	0.75
74LS195A	0.75
74LS196	0.80
74LS197	0.80
74LS221	1.00
74LS240	0.90
74LS241	0.90
74LS242	0.90
74LS243	0.90
74LS244	0.80
74LS245	1.00
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
74LS257A	0.70
74LS258A	0.70
74LS259	1.20
74LS260	0.75
74LS261	1.20
74LS266	0.60
74LS273	1.25
74LS279	0.70
74LS280	1.90
74LS283	0.80
74LS290	0.80
74LS292	9.00
74LS293	0.80
74LS295	1.40
74LS297	9.00
74LS298	1.00
74LS299	2.20
74LS231	3.70
74LS324/624	3.50
74LS348	2.00
74LS352	1.20
74LS353	1.20
74LS356	2.10
74LS363	1.80
74LS364	1.80
74LS365	0.50
74LS366	0.50
74LS367	0.52
74LS368	0.50
74LS373	0.90
74LS374	0.90
74LS375	0.75
74LS377	1.10
74LS378	0.95
74LS379	1.40
74LS381	4.50
74LS390	0.60
74LS393	1.10
74LS395A	1.00
74LS399	1.40
74LS445	1.80
74LS465	1.20
74LS467	1.80
74LS540	1.00
74LS541	1.00
74LS608	7.00
74LS610	19.00
74LS612	19.00
74LS626	2.25
74LS628	2.25
74LS629	1.40
74LS640	3.00
74LS640-1	3.00
74LS641	2.00
74LS642	2.50
74LS642-1	3.00
74LS643	2.50
74LS643-1	3.00
74LS644	3.50
74LS645	2.00
74LS645-1	4.00
74LS668	0.90
74LS669	0.90
74LS670	1.80
74LS682	3.20
74LS684	6.50
74LS687	5.50
74C922	6.50
74C923	6.50
74C925	6.50
74C926	6.50
74C928	6.50

4000 SERIES

4000	0.20
4001	0.24
4002	0.25
4006	0.70
4007	0.25
4008	0.60
4009	0.45
4010	0.60
4011	0.24
4012	0.25
4013	0.36
4014	0.60
4015	0.70
4016	0.36
4017	0.55
4018	0.60
4019	0.60
4020	0.80
4021	0.60
4022	0.70
4023	0.30
4024	0.48
4025	0.24
4026	0.90
4027	0.40
4028	0.60
4029	0.75
4030	0.35
4031	1.25
4032	1.00
4033	1.25
4034	2.50
4035	0.70
4036	2.50
4037	1.10
4038	1.00
4039	2.50
4040	0.60
4041	0.55
4042	0.50
4043	0.60
4044	0.60
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.35
4051	0.65
4052	0.60
4053	0.60
4054	0.80
4055	0.80
4056	0.85
4059	4.00
4060	0.70
4063	0.85
4066	0.40
4067	2.30
4068	0.25
4067	0.24
4068	0.25
4069	0.24
4070	0.24
4071	0.24
4072	0.24
4073	0.24
4075	0.24
4076	0.65
4077	0.25
4078	0.25
4081	0.24
4082	0.25
4085	0.60
4086	0.75
4089	1.20
4093	0.35
4094	0.90
4095	0.90
4096	0.90
4097	2.70
4098	0.75
4099	0.90
4501	0.36
4502	0.55
4503	0.36
4504	0.95
4505	3.60
4506	0.90
4507/4030	0.35
4508	1.20
4510	0.55
4511	0.55
4512	0.55
4513	1.50
4514	1.10
4515	1.10
4516	0.55
4517	2.20
4518	0.48
4519	0.32
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.80
4528	0.65
4529	1.00
4531	0.75
4532	0.65
4534	3.80
4536	2.50
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.50
4557	2.40
4560	1.40
4566	1.40
4568	2.40
4569	1.70
4572	0.45
4583	0.90
4584	0.48
4585	0.60
4724	1.50
14411	7.50
14412	7.50
14416	3.00
14419	2.60
14490	4.20
14495	4.50
14500	6.50
14599	2.00
22100	3.50
22101	7.00
22102	7.00
40014	0.48
40085	1.20
40097	0.36
40098	0.40
40100	1.50
40101	1.25
40102	1.30
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
40108	3.20
40109	0.80
40110	2.25
40114	2.25
40147	2.80
40163	1.00
40173	1.20
40174	1.00
40175	1.00
40192	1.00
40193	1.00
40194	1.00
40244	1.50
40245	1.50
40257	1.80
40373	1.80
40374	1.80
80C95	0.75
80C97	0.75
80C98	0.75

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10231	350p

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AY3-1270	7.50
AY3-1350	3.50
AY3-8910	4.00
AY3-8912	5.0
CA3019A	1.00
CA3028A	1.10
CA3046	0.70
CA3059	3.20
CA3060	3.50
CA3080E	0.70
CA3086	0.60p
CA3089E	2.10
CA3090AQ	3.75
CA3130E	0.90
CA3130T	1.30
CA3140E	0.45
CA3140T	1.00
CA3146	2.25
CA3160E	0.90
CA3161E	1.60
CA3162E	4.40
CA3189E	2.70
CA3240E	1.50
CA3280G	2.70
D7002	12.00
DAC0800	2.25
DAC0808	2.25
DG308	3.00
HA1366	1.90
ICL7106	6.75
ICL7611	8.95
ICL7650	4.00
ICL7660	2.50
ICL8038	3.00
ICM7216B	22.00
ICM7217	7.50
ICM7555	0.90
ICM7556	1.40
LC7120	3.00
LC7130	3.00
LC7431	3.50
LC7137	3.50
LF347	1.50
LF351	0.60
LF353	0.90
LF355	0.90
LF356N	0.95
LF357	1.00
LF13331	3.50
LM10CLH	4.50
LM301A	0.30
LM307	0.45
LM308CN	0.75
LM310	2.25
LM311	0.60
LM318	1.50
LM319	1.80
LM324	0.45
LM334Z	1.15
LM335Z	1.30
LM336	1.60
LM339	0.40
LM348	0.60
LM358P	0.50
LM377	2.10
LM380N-8	1.50
LM380N	1.20
LM381AN	1.70
LM382	2.00
LM383	3.25
LM384	2.20
LM386N-1	1.00
LM387	2.70
LM389	1.80
LM391	1.80
LM392N	1.10
LM393	0.85
LM394CH	3.75
LM709	0.35
LM710	0.48
LM711	1.00
LM723	0.60
LM725CN	3.00
LM733	0.65
LM741	0.16
LM747	0.70
LM748	0.30
LM1011	4.80
LM1014	1.50
LM1801	3.00
LM1830	2.50
LM1871	3.00
LM1872	3.00
LM1886	6.00
LM1889	4.50
LM2917	3.00
LM3302	0.75
LM3900	0.80
LM3909	1.00
LM3911	1.80
LM3914	3.50
LM3915	3.40
LM3916	3.40
LM13600	1.50
M51513L	2.30
M51516L	4.50
MB3712	2.00
MB3730	4.00
MC1310	1.50
MC1413	0.75
MC1445	2.50
MC1458	0.45
MC1495L	2.50
MC1496	0.70
MC3340	2.00
MC3401	0.50
MC3403	0.65
MF10CN	3.40
MK50240	9.00
MK50398	7.90
ML920	5.00
ML922	4.00
MM66221A	3.00
NE531	1.20
NE555	0.22
NE556	0.60
NE564	4.00
NE565	1.20
NE566	1.50
NE567	1.25
NE570	4.00
NE571	3.00
NE592	0.90
NE5532P	1.50
NE5533P	1.60
NE5534P	1.20
NE5534AP	1.50
OP-07EP	5.00
PLL02A	5.00
RC4136	0.55
RC4151	2.00
RC4195	1.50
RC4558	0.55
S566B	2.20
S50240	9.00
SAA1900	16.00
SFF96364	8.00
SL490	3.00
SN76013N	3.00
SN76023N	3.00
SN76033N	3.00
SN76115N	2.15
SN76489	4.00
SN76495	4.00
SN76660	1.20
SPO256AL2	7.00
SP8515	7.50
TA7120	1.20
TA130	1.40
TA7204	1.50
TA7205	0.90
TA7222	1.50
TA7310	1.50
TBA641BX1	4.00
TBA231	1.20
TBA800	0.80
TBA810	0.90
TBA820	0.90
TBA820M	0.75
TBA920	2.00
TBA950	2.25
TC9109	5.00
TCA210	3.50
TCA220	3.50
TCA940	1.75
TDA1004A	5.00
TDA1010	2.25
TDA1022	4.50
TDA1024	1.10
TDA1170S	3.00
TDA2002	3.25
TDA2003	1.90
TDA2004	2.40
TDA2006	3.20
TDA2020	3.20
TDA2030	1.80
TDA541	4.00
TDA2591	4.00
TDA2593	5.00
TDA2653	7.00
TDA3560	9.90
TDA3810	7.50
TDA7000	3.50
TEA1002	7.00
TL061CP	0.40
TL062	0.60
TL064	0.90
TL071	0.40
TL072	0.70
TL074	1.10
TL081	0.35
TL082	0.55
TL083	0.75
TL084	1.00
TL094	2.00
TL170	0.50
TL430C	1.20
UAA1003-9	9.35
UA759	3.20
UA2240	1.20
UAA170	1.70
UCN4801A	5.50
ULN2001A	0.75
ULN2002A	0.75
ULN2003A	0.75
ULN2004A	0.75
LN2068	2.90
ULN2802	1.90
ULN2803	1.80
ULN2804	1.90
UPC575	2.75
UPC592H	2.00
UPC1156H	3.00
UPC1185H	5.00
XR210	4.00
XR2206	4.00
XR2207	3.75
XR2211	5.75
XR2216	6.75
XR2240	1.20
ZN404	1.20
ZN414	0.80
ZN419P	1.75
ZN423E	1.30
ZN424E	1.30
ZN425E8	3.50
ZN426E8	3.00
ZN427E8	6.00
ZN428E8	4.50
ZN429E8	2.25
ZN447E	9.00
ZN450E	7.50
ZN459CP	3.00
ZN1034E	2.00
ZN1040	6.60
ZNA134J	23.00
ZNA234E	9.50
8703CJ	12.00

CPU's

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6502	3.50
65C02	12.00
6502A	5.50
6502B	8.00
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6802	3.00
6809	6.50
6809E	12.00
68B09	12.00
68B09E	16.00
68000-L8	36.00
8035	3.50
8039	4.20
8080A	4.20
8085A	3.00
8086	22.00
8088	17.50
8741	16.00
8748	18.00
TMS1601	12.00
TMS9980	14.50
TMS9995	12.00
WD55	14.50
Z80	2.80
Z80A	3.25
Z80B	7.00

SUPPORT DEVICES

2651	12.00
3242	8.00
3245	4.50
6520	3.00
6522	3.50
6552	2.50
6522A	5.50
6532	4.80
6551A	5.25
6821	1.50
68B21	2.20
6829	12.50
6840	3.75
68B40	6.00
6850	1.60
68B50	2.50
6852	2.50
6854	6.50
68B54	8.00
6875	5.00
8154	8.50
8155	3.80
8156	3.80
8205	2.25
8212	2.20
8216	1.60
8224	P.O.A.
8226	4.25
8228	4.50
8243	2.60
8250	9.50
8251A	3.25
8253C-5	3.50
8255AC-5	3.80
8256	18.00
8257C-5	4.00
8259C-5	4.00
8275	29.00
8279C-5	4.80
8283	4.00
8282	4.50
8284	4.60
8287	4.25
8288D	11.00
8755A-0/1/2/9	16.00
TMS4500	14.00
TMS9901	5.00
TMS9902	5.00
TMS9903	25.00
TMS9911	18.00
TMS9914	14.00
Z80P1O	2.60
Z80AP1O	2.75
Z80CTC	2.60
Z80ACTC	2.75
Z80DART	6.50
Z80ADART	8.00
Z80ADMA	7.50
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RAMS

2016-150	4.00
2101	4.00
2102	2.50
2107B	5.00
2111A-35	4.00
2114-2	3.50
2114-3	2.50
2114-4	2.00
2147	3.20
4027-3	3.00
4116-15	4.50
4116-20	1.50
4118-3	5.00
41256-15	16.00
4164-15 (TI)	5.00
4164-15	4.50
4164-20	4.20
4416-15	5.00
4532-20	2.50
4816AP-3	2.00
5101/5501	3.70
5516	6.50
6116P-3	4.50
6116LP-3	5.00
6264-15	13.00
6514-45	2.50
6810	1.60
74S189	2.25
74S201	3.50
74S289	2.25
93415	6.00
93L422	9.50
93425	6.00

ROMS/PROMS

28L22	4.00
24S10	2.50
18S030	2.00
18SA030	2.00
74S188	1.80
74S287	2.25
74S288	1.80
74S387	2.25
74S473	4.75
74S474	5.50
74S570	3.20
74S571	3.50
74S573	3.50
82S23	1.50
82S123	1.50
82S129	1.75

EPROMS

2516 + 5V	3.50
2516-35	5.50
2532	4.50
2532-30	5.50
2564	6.50
2708	3.00
2716 + 5V	3.50
2716-35	5.50
2732	4.50
2732A-2	7.00
2732A-30	6.00
2732A-35	5.00
2764-25	4.90
27C64-25	14.00
27128-25	12.00
27128-30	11.50
27256-25	36.00
27256-30	34.00
TMS2716	5.00

CRT CONTROLLER

CRT5027	18.00
CRT6545	9.00
EF9364	8.00
EF9365	25.00
EF9366	25.00
EF9367	36.00
MC6845	6.50
MC6845SP	6.50
MC6847	6.50
SFF96364	8.00
TMS9918	15.00
TMS9927	7.50
TMS9928	10.00
TMS9929	10.00

CRYSTALS

32.768 kHz	1.00
1.00 MHz	2.70
1.8432 MHz	2.25
2.00 MHz	2.25
2.45760 MHz (S)	2.00
2.5 MHz	2.50
2.662 MHz	2.50
3.12 MHz	1.75
3.276 MHz	1.50
3.5795 MHz	1.00
4.00 MHz	1.40
4.194 MHz	1.50
4.43 MHz	1.00
4.608 MHz	2.50
4.9152 MHz	2.00
5.000 MHz	1.50
6.00 MHz	1.40
6.144 MHz	1.40
7.00 MHz	1.50
7.168 MHz	1.75
8.00 MHz	1.50
8.867 MHz	1.75
10.00 MHz	1.75
10.50 MHz	2.50
10.70 MHz	1.50
11.00 MHz	3.00
12.00 MHz	1.50
14.00 MHz	1.75
14.318 MHz	1.60
14.756MHz	2.50
15.00 MHz	2.00
16.00 MHz	2.00
17.734 MHz	2.00
18.00 MHz	1.70
18.00 MHz	1.70
18.432 MHz	1.50
19.969 MHz	1.50
20.000 MHz	1.75
24.000 MHz	1.50
48.00 MHz	1.75
116 MHz	2.50
PXO1000	12.00

DISC CONTROLLERS

6843	8.00
8272	26.00
FD1771	20.00
FD1791	20.00
FD1793	20.00
FD1795	28.00
FD1797	22.00
WD2793	36.00
WD2797	32.00
WD1691	15.00
WD2143	8.00

CHARACTER GENERATORS

RO-3-2513 UC	7.50
RO-3-2513 LC	7.00
DM86S64	12.00
MCM66760	7.50

BAUDRATE GENERATOR

MC14411	7.50
COM8116	6.50
4702B	7.50

KEYBOARD ENCODER

AY-5-2376	11.50
AY5-3600	7.50
74C922	6.50
74C923	6.50

UHF MODULATORS

6 MHz	3.75
8 MHz	4.50
SOUND & VISION 12 MHz	12.00

INTERFACES ICS

AD561J	20.00
ADC0808	12.00
AM25S10	3.50
AM25LS2521	3.50
AM25LS2538	3.50
AM26LS31	1.20
AM26LS32	1.20
AM7910DC	25.00
DAC80-CB1-V	28.00
DM8131	6.00
DP8304	3.50
DS3691	5.00
DS8830	1.40
DS8831	1.50
DS8832	1.50
DS8833	2.25
DS8836	1.50
DS8838	2.25
LF13201	4.50
MC1488	0.60
MC1489	0.60
MC3446	2.50
MC3459	4.50
MC3470	4.75
MC3480	8.50
MC3486	2.25
MC3487	2.25
MC4024	6.00
MC4044	6.00
MC14411	9.00
MC14412	7.50
75107	0.90
75108	0.90
75109	1.20
75110	0.90
75112	1.60
75113	1.20
75114	1.40
75115	1.40
75121	1.40
75122	1.40
75150P	1.20
75154	1.20
75159	2.20
75160	5.00
75161	3.50
75162	4.00
75172	3.00
75182	0.90
75188	0.60
75189	0.60
75365	1.50
75451	0.50
75452	0.50
75453	0.70
75454	0.70
75480	1.50
75491	0.65
75492	0.65
8T26	1.20
8T28	1.20
8T95	1.20
8T96	1.20
8T97	1.20
8T98	1.20
81LS95	1.40
81LS96	2.20
81LS97	1.40
81LS98	2.20
81LS120	5.00
9602	3.00
9636A	1.60
9637AP	1.60
9638	1.60

REAL TIME CLOCK

MC6818P	4.50
MM58174AN	8.50
MSM5832RS	3.50

TELETEXT DECODER

SAA5020	6.00
SAA5030	7.00
SAA5041	16.00
SAA5050	9.00

UARTS

AY-3-1015P	3.00
AY-5-1013P	3.00
COM8017	3.00
IM6402	3.60
TR1602	3.00

VOLTAGE REGULATORS

1A FIXED VOLTAGE PLASTIC TO220

+ VE			− VE	
5 V	7805	0.45	7905	0.50
6 V	7806	0.50	7906	0.50
8 V	7808	0.50	7908	0.50
12 V	7812	0.45	7912	0.50
15 V	7815	0.50	7915	0.50
18 V	7818	0.50	7918	0.50
24 V	7824	0.50	7924	0.50

1A FIXED VOLTAGE PLASTIC TO92

5 V	78L05	0.30	15 V	78L15	0.30
6 V	78L06	0.30	5 V	79L05	0.45
8 V	78L08	0.30	12 V	79L12	0.50
12 V	78L12	0.30	15 V	17L15	0.50

OTHER REGULATORS

LM309K	1.40
LM323K	3.50
78HO5KC 5 A 5 V	5.90
78H12	6.40
78PO5	9.00

SWITCHING REGULATORS

ICL7660	2.50
SG3524	3.00
TL494	3.00
TL497	3.00
78S40	2.50
RC4195	1.50

VARIABLE REGULATORS

LM305AH	2.50	LM723N	0.50
LM317T	1.50	78HGKC	7.00
LM317K	2.40	78GUIC	2.25
LM337T	2.25	79HGKC	7.75
LM350T	4.00	79GUIC	2.50
LM396K	15.00	79MGT2C	1.40

OPTO-ISOLATORS

ILD74	1.30	TIL112	0.70
ILQ74	2.20	TIL113	0.70
MCT26	1.00	TIL116	0.70
MCS2400	1.90	6N137	3.60
MOC3020	1.50	6N139	1.75
TIL111	0.70		

DISPLAYS

DL704 RED	1.40	MAN4640	2.00
DL707 RED	1.40	MAN6610	2.00
FND357	1.00	NSB5881	5.70
FND500/TIL730	1.00	TIL311	6.50
FND507/TIL729	1.00	TIL729	1.00
MAN74/DL704	1.00	TIL730	1.00
MAN71/DL707	1.00	MAN8910	2.50
MAN3640	1.75	MAN8940	2.50

DISPLAY DRIVERS

9368	4.50	ULN2004	0.90
9370	4.50	ULN2068	2.90
LM3914	3.50	ULN2802	1.90
LM3915	3.50	ULN2803	1.80
LM3916	3.50	ULN2804	1.90
UDN6118	3.20	75491	0.70
UDN6184	3.20	75492	0.70
ULN2003	0.90		

OTHERS

2N5777	0.50	ORP12	1.20
BPX25	1.80	ORP60	1.20
BPW21	2.80	ORP61	1.20
OCP71	1.80	SFH205	1.00

ATTENTION ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

2.7V-33V	
400MW	9p
1W	15p

TRIACS

Plastic	
3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
T1226D	70p

DISCRETE DISPLAYS LEDS

125" RED TIL209	0.12
GREEN TIL211	0.16
YELLOW TIL212	0.20
Rect LEDs (R/G/Y)	0.30
CXQ (Bi Colour	1.00
10 LED Bargraph: Red	2.25
Green	2.25
0.2" TIL220	0.15
TIL222	0.18
TIL226	0.22
TIL32	0.55
TIL78	0.55
TIL31B	1.20
TIL81	1.20
TIL100	0.75

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	75p
14 pin	42p	20 pin	60p	28 pin	100p
16 pin	45p	22 pin	65p	40 pin	130p

Turned Pin Low Profile Sockets

8 pin	20p	16 pin	30p	20 pin	40p	28 pin	60p
14 pin	25p	18 pin	35p	24 pin	50p	40 pin	90p

TRANSISTORS

BC107/8	18p	BC557B	18p	BFY50/51	30p	TIP36C	150p	2N3055	55p
BC109B	18p	BC558B	18p	BFY52	30p	TIP41C	50p	2N3442	140p
BC109/C	20p	BC559C	24p	BFY90	90p	TIP42A	60p	2N3702/3	16p
BC141	40p	BCY71	36p	MJ2501	225p	TIP42C	65p	2N3704/5	16p
BC161	40p	BCY72	30p	MJ2955	90p	TIP47	90p	2N3773	200p
BC177	30p	BD131	75p	MJ3001	225p	TIP54	160p	2N3819	40p
BBC179	30p	BD132	80p	MJE2955	150p	TIP55	180p	2N3866	90p
BC182/L	15p	BD135	40p	MJE3055	125p	TIP125	70p	2N3904/6	18p
BC184/L	20p	BD136	40p	MPF102	40p	TIP2955	90p	2N4871	50p
BC212/L	16p	BD139	40p	MPF103/4	40p	TIP3055	70p	2N5245	40p
BC213/L	16p	BD241B	75p	MPF105	40p	2N2160	350p	2N5457/8	30p
BC214/L	18p	BD242B	75p	MPSA12	50p	2N2219A	30p	2N5459	30p
BC327	16p	BD244B	40p	TIP29C	40p	2N2222A	30p	2N5883	375p
BC338	16p	BF256B	50p	TIP31B	40p	2N2484	30p	2N6027	30p
BC477	36p	BF257/8	40p	TIP31C	45p	2N2646	50p	3N128	200p
BBC516/7	50p	BF259	40p	TIP32C	45p	2N2905A	30p	3N140/1	200p
BBC547/B	20p	BF337	36p	TIP33C	80p	2N3053	36p	40673	90p
BBC548C	16p	BFR80/81	32p	TIP35C	140p	2N3054	60p		

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way	50 way
Header Plug	90p	145p	175p	200p	220p	235p
Receptacle	85p	125p	150p	160p	190p	200p
Edge Conn.	120p	195p	240p	320p	340p	390p

EURO CONNECTORS

	Plug	Socket
DIN 41612 2 · 32-way	300p	350p
angled 2 · 32-way	350p	400p
angled 3 · 32-way	400p	—
(for 2 · 32 way specify a · b or a · c)		
DIN 41617 21-way	160p	165p
DIN 41617 31-way	170p	170p
DIN 41612		
2 x 32 way St Pin	230p	275p
2 x 32 way Ang Pin	275p	320p
3 x 32 way St Pin	260p	300p
3 x 32 way Ang Pin	375p	400p
1 DC Skt A + B	275p	
A + C	350p	

For 2 x 32 way please specify spacing (A + B, A + C)

DIODES

BY127	12p	OA200	9p	IN4003/4	5p
OA47	10p	OA202	10p	IN4006/7	7p
OA90	9p	IN914	4p	IN5401/2	12p
OA91	9p	IN4148	4p	IN5403/4	14p
OA95	9p	IN4001/2	5p	IS920	9p

BRIDGES

1A50V	19p	2A400V	45p	6A100V	100p
1A100V	20p	3A200V	60p	6A400V	120p
1A600V	30p	4A100V	95p	8A100V	150p
2A50V	30p	4A400V	100p	10A100V	180p
2A100V	35p	6A50V	80p	10A400V	200p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way	50 way
		MALE			
solder	60p	85p	1.25p	2.40p	4.00p
angled	1.20p	1.80p	2.40p	3.50p	—
		FEMALE			
solder	90p	1.30p	1.95	2.90p	5.00p
angled	1.60p	2.10p	2.90p	4.40p	—
hood (top/side entry)	90p	85p	90p	1.00p	—

25 way Centronix Type Conn. .... 5.50 pound
37 way Centronix Type Conn. .... 5.50 pound
IDC 25 way plug 3.85p Socket 4.50p.

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Editor: P.V. Holmes
Assistant editor: E.J.A. Krempelsauer
UK editorial staff:
L. Seymour
Overseas editorial staff:
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A special-effect unit as seen on TV

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A simple-to-build and accurate unit for use wherever a precise 19 kHz signal is required.

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In response to many requests, we have developed a counter that will meet most of your requirements.

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A simple aid for all householders in their fight against the growing menace of being burgled.

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A good-quality speaker that can be connected direct to the headphone output of cassette players and FM receivers.

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1985
elektor
electronics
Versatile module
counts up and down; presets and latches; drives any 7-segment display — LED, LCD, common cathode or common anode
active mini
15 watts — 1 litre
200 Hz — 20 kHz
KITT scanner
the secret behind those robot eyes: why they look as if they're looking
push and pull
both stages driven all the way: a power amplifier in class A!

A selection from our April issue:

- the first cuckoo in spring . . .
- real-time-clock for micros
- X-Y plotter
- solar cell receiver
- rev counter with power curve
- 10 A power supply

We regret that owing to circumstances beyond our control it has been necessary to shift the 'X-Y plotter' from March to the April issue.

This month's cover depicts an example of the 'versatile counter' module which is described on pages 3-54/57 in this issue.

back number service

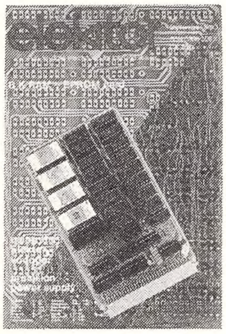
E34, February 1978
Infra-red Light Gate/Throwing Some Light on LEDs/Formant – the Elektor Music Synthesiser (8)/Slow on/off/CMOS Function Generator/Zener Tester/Development Timer/Experimenting with the SC/MP (4).

E38, June 1978
1/4 GHz Counter/Constant Amplitude Squarewave to Sawtooth Converter/Servo Polarity Changer/ Monopoly Dice/ Mini Counter/Digital Clock Using the SC/MP/Programmable Call Generator/TV Sound Modulator/ Automatic Stereo Switch/Traffic Light Controller/Easy Music.

E54, October 1979
Touch Tuning/Battery Saver/Impedance Bridge/New Programs for the SC/MP/Digital Rev Counter/Digifarad/Short-interval Light Switch/PCB for Variable Fuzz Box/Gate-dipper/Strain Gauge/I Played TV Games/Programmable Sequencer.

E55, November 1979
Topamp/Flash Sequencer/Electronics the Easiest Way/Remote Control Motor Switch/ Home Trainer/Fuel Economiser/ I Played TV Games (2)/Shortwave converter/Ionosphere/Low Voltage Dimmer/I See your Point/Servo-controlled Motor.

E58, February 1980
Aerial Booster/Fet Opamps in the Formant/TV Interference Suppression / Elektor Vocoder (2)/Aerial Amplifiers/Digisplay/ Analogue Delay Technology/Extending the 1/4 GHz Counter/ Digital Thermometer.



E65, September 1980
8K RAM +4.8 or 16K EPROM on a Single Card/Precision Power Unit/Electronic Linear Thermometer/The Josephson Computer/VOX Printed Circuit Board/Ejektor: Measuring Multipath/High Speed Readout for Elekterminal/Musical Box/Electrolytology/Curve Tracer/Using the Vocoder.

E66, October 1980
Programmable Slide Fader/Touch Doorbell/Switched Capacitors/ More TV Games/The Junior Computer Memory Card/Remote Control Slide Projector/Video Pattern Generator/LCD Tuning Scale/Dual Slide Faders.

E67, November 1980
An r.p.m. Indicator as an Economy Guide/Draught Detector/How to Recycle Dry Cell Batteries/Energy Saving Knowhow/Simple Fuel Economy Meter/Automatic Pump Control /Long Life Technique in Light Bulbs/Automatic Curtain Control/Fridge Alarm/Know the ins and outs of your Central Heating System/Energy Saving Motor Control/Coffee Machine Switch/ Operational Hours Counter.

E68, December 1980
Canned Circuits: 23 of the best entries which include Midnight Raid Detector/A 'Flash in the Can' / Canometer / Canine Defence.

E70, February 1981
Audio Power Meter/Noise Reduction / Process Timer / High voltage from 723 / Juniors Growing Up/The Voiced/Unvoiced Detector / Emergency Brake for the Power Supply/ 150 W DC to DC Converter for the Car/Low Noise 2 Metre Pre-Amp/2½ Digit DVM/Wagnephon.

E72, April 1981
Transistor Match-maker/Universal Power Supply/Intelekt/Humidity Sensor/Logic Analyser II/ Crystal-controlled Stroboscope/ Junior Cookbook.

E73, May 1981
Camping Clock / Frequency Doubler/The Fully Fledged Junior Computer/Talk to Computers/Choke Alarm/Bar Codes/ Logic Analyser/Waveform Generator/Sophisticated Software for the Junior Computer/Reading Bar Codes.

E77, September 1981
DFM + DVM/Revolution Counter/Digital Barometer/dB Converter/TV Games Extended/ Disco Lights Controller/QUAD ESL 63/Analogue LED Display/ Volt/Ammeter for Power Supplies/Chattering Chips/Transistor Ignition Update/Soldering Aluminium.

E89, September 1982
Gas Detector/Rapid Loading Games/The Elektor Connection/ Inductive Sensor / Darkroom Computer Part 1 / Applikator/ Home Telephone System/Synthesised Sound Animation/Time Receiver for the Rugby MSF/ Three Phase Tester.

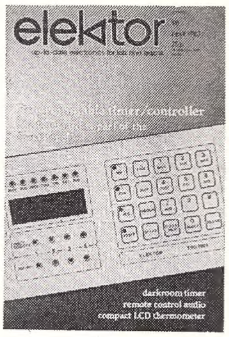
E90, October 1982
DSB Demodulator/L.C.D. Thermometer/Ultra Sonic Distance Measurement/Electrolytics Run Dry/Darkroom Computer Part 2/Short Wave Band Shifting for SSB Receiver/16 Channels with only Five ICs/Pre-amp for the SSB Receiver / Active Aerial / Transistor and IC Data.

E91, November 1982
Drum Interface/Talking Dice/ Model Train Lighting/Guitar Tuner/Cerberus/Floppy Disc Interface for the Junior/Cubular Bell/Mini-Organ Extension/ Kitchen Timer.

E93, January 1983
Milliohmmeter/accessories for the Crescendo power amplifier/ Darkroom computer tips/Chips for digital audio/3 A computer supply/Traffic-light control system / Tomorrow's music / Upper and lower case on the Elekterminal.

E94, February 1983
Prelude part 1/VAM – video/ audio modulator / Main beam dimmer/Prelude class A headphone amplifier/Fuse protector/ Acoustic telephone modem/ Double dice/Chips for digital audio part 2.

E96, April 1983
Low power digital thermometer/ MC/MM phono preamp/Membrane switches/Interlude/RC equalizer/7-day timer/controller/Junior program tester/Prelude (part 3)/Programmable darkroom timer/Talking clock extension.



E97, May 1983
Wattmeter/ASCII keyboard/Prelude p.s./Multitester/Maestro (part 1)/What is power?/Parallel-serial keyboard converter/Morse converter/78L voltage regulators . . and 79L/Morse decoding with the Z80A.

E99/100, July/August 1983
Summer Circuits Double Issue containing over 100 projects.

E101, September 1983
Video Graphics / Autotest / 64k on the 16k Dynamic RAM Card / high-speed CMOS / VDU Card / Personal FM / Precision Voltage Divider / Alarm Extension / Junior Synthesizer / Simple MOSFET Test.

E102, October 1983
Basicode-2 / Music Quantisizer / Solid-state Darkroom Lighting / High-voltage Regulator / Anemometer / Programmable Power Supply / Basicode-2 Interface for the Junior Computer / Electronic Voltage Regulator / Battery Eliminator / Transistor Selector / FSKleaner / EPROMmer using the Junior Computer.

E103, November 1983
Doorbell – or telephone – operated flashlight/Power Controller for Model Railways/ Decoupling in Digital Circuits/ CPU Card/Decimal to Binary Converter/Movement Detector/ Electronic two-tone Metronome/ Pseudo Stereo/Universal Terminal/Ultrasonic/Infrared Barrier/Trick Battery/Crescendo revisited.

E104, December 1983
64-way 2-dimensional Bus Board /MF/HF USB Marine Receiver/ LED Ornaments/Symmetrical Power Supply/Video Amplifier/ Locomotive Headlamp Reverser/ Frost Warning Device/Disco Phaser/Banking Program/NOVRAM: Data Storage without Batteries/Bus Extension/ + Cumulative index 1983.

E105, January 1984
Gyrophone/How accurate is your watch? /Digital Cassette Recorder/Audio Signal Embellisher/Universal Active Filter/ from Thermometer to Thermostat/Audio Sleuth at work/Wind Direction Indicator/Z80 EPROM programmer/Home-made low-cost Wiring Probe/Address decoding.

E106, February 1984
6502 Tracer/Diesel Tachometer/ Programmable Disco Display Lights/Video Combiner/Digitester with a difference/Reversing Buzzer/Memory timing/ Mating Logic Families/CapacitanceMeter/Basicode 2 for Junior plus VDU Card/Constant Voltage Source/CS Chip Selekt/ Video Sync Box.

E107, March 1984
Petrol Saver/Triac Control Board /UHF Video and Audio Modulator/ GET & GO/Elabyrinth/ Varistor Protection Circuits/ Real-Time Analyser (part 1)/ Applicator/Tape Timer.

E108, April 1984
Optical Memories/Controlling the Floppy-disk Drive Motor/Pulse Generator/Using the Pulse Generator/Intelligent EPROM Eraser/ Z80 Simulator/Metronome Extension/Real-time Analyser, part 2/ Variable A.C. Power Supply/ Idlist/Chip Selekt/Tape Contents Detector.

E109, May 1984
Noise Squelch/Short-wave Pocket Radio/Floppy Tester/Switching Power Supply/Analytical Video Display/Aviary Illumination/How many Watts?/Mini Crescendo/a look at EXOR and EXNOR Gates/ EPROM Copier/Digital Cassette Recorder revisited/Real-time Analyser, part 3/RS423 Interface.

E110, June 1984
Portable Distress Signal/ZX Extensions/Disco Drum/Daisywheel Typewriter Printer Interface/Maximum and Minimum Memory/ Lead-acid Battery Charger/Wireless Microphone/Merging BASIC Programs/Echo Sounder/Versatile Audio Peak Meter.

E111/112, July/August 1984
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E113, September 1984
Data Communication by Telephone/Active cross-over Filter/ Digital Cassette Recorder with the ZX81/Flash Meter/Digital Tachometer/DIRPUT/SCART Adapter/Anodizing Aluminium/Lamp Saver/Double-sided Printed Circuit Boards.

E114, October 1984
The Sinclair QL – first impressions/Basicode-2/Tuning Fork/ Balancing Transformers/Video Colour Inverter/Programming the 6845/ZX81 Cassette Pulse Cleaner/Direct-coupled Modem/Battery Tester/RS232 Centronics Converter/Dynamic Pre-amplifier.

E115, November 1984
The Story of Valves/Autodim/ Mini Printer/Burglar Deterrent/ How to make your own PCBs/ RS232/V24: the Signals/Use your TV Receiver as a Monitor/Telephase/Valve Amplifier/Electronic Gas Meter.

E116, December 1984
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E117, January 1985
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E118, February 1985
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39n, 56n	2p
82n, 100n	11p
100V	
110n, 100n	10p
150n, 180n	12p
220n, 270n	12p
330n, 390	20p
470n, 560n	26p
680r	30p
1uF 34p 2u2	50p

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1N916	5
1N4001/2	5
1N4003	6
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16A 400V	106
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T2800D	125

DIAC

ST2	25

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75110	90
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75154	125
75158	150
75195	195
75182/3	99
75188/9	100
75322	140
75324	360
75325	00
75365	00
75450	86
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75454	70
75491/2	65

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68000	£30
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8224	350
8225	£11
8226	350
8228	270
8243	550
8250	£11
8251A	795
8253	750
8255	650
8256 AC	£15
8257 A	400
8259	700
8271	P.O.A.
8272	£25
8279	750
8282	450
8283	00
8284	550
8285	365
8287	00
8288	£11
8303	450
8304	350
8T26A	99
8T27	150
8T31	350
8T95	90
8T97N	90
9602	220
AM26LS31C	125
AM26LS33	150
AM7910	£30
AY-5-1013	300
CD4724	150
COM8017	275
COM8116	700
D8748	£55
DM8131	475
DS3691N	595
DS88LS120	395
DS8820	110
DS8830	198
DS8831	125
DS8832	250
E9364	800
E9365	£36
FD1691	£15
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
FD1799	£28
HD26501	75
HM6845	755
IM6402	350
INS8060N	1250
INS8154N	£9
MC1488	100
MC1489	100
MC14411	690
MC14412	725
MC3446	250
MC3447P	315
MC3486	225
MC3487	225
MC6845	625
MC6846	625
MK3886-2M	£7
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	865
MM58174	875
MM74C922	750
RO-3-2513L	700
RO-3-2513U	750

SAA5050	875
SFF9634E	800
SPO256AL2	495
TCM3101J	£13
TMS2716	725
TMS4164	395
TMS4416-2	595
TMS4500	£12
TMS5100	600
TMS9927	£14
TMS9928	£20
TMS9929	£20
TMS9995	£12
UPD7002	725
UPD7007	725
WD1691	£14
WD1770	1995
WD2143	850
Z80CPU 2.5M	300
Z80A CPU4M	375
Z80 CTC	285
Z80A CTC	335
Z80B	£11
Z80 DART	698
Z80A DART	820
Z80 ADMA	925
Z80 DMA	795
Z80 PIO	325
Z80 A PIO	350
Z80 SIO-1	850
Z80 A SIO	£9
Z80 AS10-2	£9
Z8002 CPU	00

LINEAR ICs

555CMOS	95
702	75
709C 8 pin	35
710	48
741-8 pin	16
747C 14 pin	70
748C 8 pin	30
753 8 pin	185
810	159
9400CJ	375
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-16720	210
AY-3-1350	350
AY-3-8910	390
Booklet for AY-3-8910	200
AY-3-8912	500
AY-5-1317A	630
AY-5-1350	388
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	110
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3048	220
CA3059	325
CA3075	213
CA3080E	75

TRANSISTORS

AD142	120
AD149	79
AD161	42
AD162	42
AF118	80
AF139	40
AF239	55
BC107	12
BC107B	14
BC108	12
BC108B	14
BC108C	14
BC109	12
BC109B	14
BC109C	14
BC114/5	30
BC117/8	25
BC137/9	40
BC140	38
BC142/3	38
BC147	12
BC147B	15
BC148	12
BC148B	15
BC149	12
BC149C	15
BC153/4	30
BC157/8	14
BC159	11
BC160	46
BC167A	14
BC168C	12
BC169C	12
BC170	20
BC171/2	12
BC173	15
BC177/8	16
BC179	20

BC181	30
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	28
BC212	10
BC212L	12
BC213	10
BC213L	12
BC214	10
BC214L	12
BC237/8	15
BC256B	35
BC307B	15
BC308	16
BC318	30
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	15
BC556/7	15
BC558/9	15
BCY41/42	30
BCY58/59	36
BCY70/71	18
BCY72	25
BCY78	30
BD121	96
BD124	115
BD131/32	65
BD133	70
BD135	46

BD136/37	40
BD138/39	40
BD140	40
BD144	190
BD158	68
BD205/6	110
BD245	65
BD378	70
BD434	70
BD517	75
BD645	80
BD695A	150
BD696A	150
BF115	45
BF154/8	30
BF167	35
BF173	35
BF177	35
BF178	35
BF179	40
BF184/5	38
BF194/5	12
BF198/9	18
BF200	80
BF224A	40
BF224B	40
BF245	50
BF256A	45
BF256B	50
BF257/8	32
BF259	40
BF275	55
BF336/7	35
BF494/5	40
BFR39/40	25
BFR41/79	25
BFR80/81	25
BFR98	106
BFX29	35
BFX81	45

BFX84	35
BFX85/6	35
BFY50/51	30
BFY52	30
BFY53	35
BFY55/6	35
BFY64	40
BFY81	120
BFY90	80
BFY39	50
BSX20	30
BSX26/29	45
BSY26	35
BSY95	35
BU105	180
BU205	190
BU206	200
BU208	200
BUY69C	225
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	96
MJE521	96
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	30
MPSA08	30
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	40

MPSU02	58
MPSU05	60
MPSU06	60
MPSU52	65
MPSU55	60
MPSU56	60
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	75
TIP34A	85
TIP34C	105
TIP35A	120
TIP35C	130
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	120
TIP147	120
TIP2955	70
TIP3055	70
TIS44/5	45
TIS /74	50
TIS88A	50
TIS90/91	30
UC734	65
VK1010	99
VN10KM	70

VN46AF	95
VN66AF	110
VN88AF	120
VN89AF	120
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N707a	25
2N708	25
2N918	40
2N1131/2	40
2N1671b	160
2N2160	325
2N2219a	28
2N2220a	26
2N2221a	26
2N2222	25
2N2368	25
2N2369A	18
2N2483/A	27
2N2646	46
2N2904/5	28
2N2907	28
2N2926	10
2N3053	25

2N3055	50
2N3614	180
2N3702/3	10
2N3819	35
2N3820	60
2N3822	60
2N3904	18
2N3906	18
40673	75

RF CHOKES Miniature PCB type

1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u,	30p
1mH, 1m5, 2m2, 4m7, 10mH,	35p
22m, 33m, 43m,	60p
100m	75p

CA3081	190
CA3085	160
CA3086	60
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	50
CA3160	95
CA3161	160
CA3162	450
CA3189	275
FC347	175
FC353	175
FC525	525
HA 1336W	240
HA1388	235
ICL7106	690
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038C	360
ICL8211A	225
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216B	£22
ICM7216C	£22
ICM7217A	750
ICM7224	£11
ICM7240	300
ICM7555	105
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7120	300
LC7130	320
LC7137	350
LF347	150
LF351	70
LF353	90
LF355	90
LF356	90
LF357	100
LF398	495
LM10	325
LM301A	30
LM307	45
LM308T	75
LM311	60
LM318N	175
LM319	180
LM324A	45
LM334Z	160
LM335Z	135
LM337	275
LM339	40
LM348	60
LM349	125
LM358	50
LM377	210
LM379	495
LM380	120
LM381N	175
LM382	200
LM384	225
LM386	110
LM387	200
LM389	160
LM393	85
LM394CH	385
LM558	170
LM725CN	300
LM733	65
LM1458	45
LM1871	300
LM1875	475
LM1889	350
LM2907	395
LM2917	325
LM3900	70
LM3909N	100
LM3911	185
LM3914	300
LM3915	385
LM3916	300
LM13600	150
LS7220	280
M51513L	230
M51515L	320
M51516L	475
MB3712	200
MB3756	440

MC1204	250
MC1301	90
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1455	50
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	75
MC3401	50
MC3403	95
MC3404	85
MC3405	150
MC3422	00
MC3423	80
MC3442	00
MC3487	00
MC4016	00
MF10	350
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	160
NE543K	225
NE544	200
NE555	25
NE556	65
NE560	350
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	150
NE5534A	160
OM335	650
RC4136D	60
RC4558	60
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SL6270CD	150
SL6370	170
SN76013	350
SN76023ND	240
SN76033	350
SN76227N	95
SN76477	470
SN76488	525
SP8629	350
SPO256AL	495
TA7120	140
TA7130	150
TA7204	150
TA7205	90
TA7222	150
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TCA220	350
TCA270Q	350
TCA280A	220
TCA965	180
TDA1008	310
TDA1010	235
TDA1022	499
TDA1024	115

TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	198
TDA2004	300
TDA2006	330
TDA2020	320
TDA2030	190
TDB0701	420
TL170	50
TL430	90
TL507	110
TL509	110
TLO61CP	40
TLO62CP	65
TLO64CN	98
TLO71CP	40
TLO72CP	76
TLO74CN	150
TLO81CP	35
TLO82CP	60
TLO83CP	75
TLO84CN	120
TLO91CP	60
UA2240	120
UA78540	230
UAA170	170
UAA180	180
ULN2003	90
ULN2004	90
ULN2283	100
ULN2803	190
UPC575	275
UPC1025H	375
UPC1156H	295
UPC1181	425
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN423E	130
ZN424E	130
ZN425E	595
ZN426E	300
ZN427E	600
ZN428E	450
ZN429E	245
ZN459	245
ZN1034E	200
ZN1040E	665
ZNA234E	925

TTL74

7400	25
7401	25
7402	25
7403	25
7404	30
7405	30
7406	40
7407	40
7408	25
7409	25
7410	25
7411	25
7412	25
7413	50
7414	60
7416	35
7417	35
7420	25
7421	50
7422	40
7423	35
7425	35
7426	40
7427	35
7428	35
7430	25
7432	30
7433	30
7437	30
7438	40
7440	30
7441	90
7442	65
7443	150
7444	100
7445	110
7446	110
7447	95

7448	110
7450	30
7451	30
7453	30
7454	30
7460	30
7470	50
7472	50
7473	50
7474	45
7475	55
7476	45
7480	60
7481	175
7482	100
7483	100
7484	105
7485	100
7486	40
7489	200
7490	60
7491	70
7492	70
7493	50
7494	100
7495	60
7496	75
7497	200
74100	175
74104	70
74105	70
74107	45
74109	70
74110	55
74111	55
74116	160
74118	100
74119	160
74120	90
74121	45
74122	65
74123	75
74125	60
74126	60
74128	55
74132	70
74136	50
74141	85
74142	235
74143	250
74144	250
74145	100
74147	160
74148	130
74150	170
74151	60
74153	70
74154	130
74155	75
74156	90
74157	75
74159	170
74160	100
74161	100
74162	100
74163	100
74164	110
74165	100
74166	130
74167	250
74170	190
74172	400
74173	130
74174	100
74175	100
74176	100
74177	110
74178	130
74179	130
74180	100
74181	300
74182	120
74184	170
74185	170
74190	120
74191	120
74192	120
74193	120
74194	100
74195	75
74196	120
74197	100
74198	200
74199	200
74221	200
74246	130
74247	120

74248	145
74249	175
74251	90
74259	150
74265	260
74273	180
74276	130
74278	160
74279	80
74283	100
74284	440
74285	300
74286	90
74290	80
74293	80
74297	175
74298	160
74351	180
74365	70
74366	70
74367	70
74368	70
74376	120
74390	100
74393	100
74425	60
74426	60
74490	100

74C

74C244	150
74C245	150
74C373	180
64C374	425
74C922	625
74C923	645
74C925	650

74S

74S00	40
74S02	40
74S03	40
74S04	40
74S05	40
74S08	40
74S09	40
74S10	40
74S11	40
74S15	60
74S20	40
74S22	40
74S30	60
74S32	50
74S37	50
74S38	70
74S40	40
74S51	40
74S64	40
74S65	40
74S74	70
74S85	295
74S86	100
74S112	100
74S113	100
74S114	100
74S124	300
74S132	90
74S133	50
74S134	60
74S135	110
74S138	170
74S139	170
74S140	60
74S151	140
74S153	140
74S153	140
74S157	200
74S158	190
74S162	300
74S163	300
74S168	300
74S169	300
74S174	250
74S175	300
74S181	£11
74S182	250
74S188	200
74S189	225
74S194	280
74S195	320
74S196	395
74S197	300
74S201	250
74S225	500
74S226	350
74S240	375
74S241	375
74S244	474

74S251	225
74S257	225
74S258	225
74S260	70
74S262	£10
74S274	£10
74S275	£10
74S280	425
74S281	885
74S283	295
74S287	200
74S288	180
74S289	200
74S299	595
74S301	350
74S365	250
74S373	375
74S374	375
74S381	550
74S412	380
74S470	325
74S471	600
74S472	400
74S474	400
74S475	425
74S571	300
74S573	450

74LS

74LS00	25
74LS01	25
74LS02	25
74LS03	25
74LS04	25
74LS05	25
74LS08	25
74LS09	25
74LS10	25
74LS11	25
74LS12	25
74LS13	35
74LS14	55
74LS15	25
74LS20	25
74LS21	25
74LS22	25
74LS24	55
74LS26	25
74LS27	25
74LS28	25
74LS30	25
74LS32	50
74LS33	25
74LS37	25
74LS38	30
74LS40	25
74LS42	55
74LS47	90
74LS48	90
74LS49	100
74LS51	30
74LS54	30
74LS55	30
74LS63	55
74LS73	30
74LS74	35
74LS75	45
74LS76	40
74LS78	40
74LS83	70
74LS85	80
74LS86	35
74LS90	50
74LS91	90
74LS92	55
74LS93	50
74LS95	70
74LS96	90
74LS107	45
74LS109	45
74LS112	45
74LS113	40
74LS114	40
74LS122	70
74LS123	100
74LS124	125
74LS125	50
74LS126	50
74LS132	60
74LS133	50
74LS136	50
74LS138	60
74LS139	60
74LS145	115
74LS147	165
74LS148	130
74LS151	70
74LS153	70

74LS154	20
74LS155	7
74LS156	7
74LS157	6
74LS158	6
74LS160	7
74LS161	7
74LS162	7
74LS163	7
74LS164	8
74LS165	11
74LS166	15
74LS168	14
74LS169	12
74LS170	16
74LS173	10
74LS174	10
74LS175	7
74LS181	19
74LS183	19
74LS190	8
74LS191	8
74LS192	8
74LS193	8
74LS194	7
74LS195	7
74LS196	8
74LS197	8
74LS221	8
74LS240	9
74LS241	9
74LS242	9
74LS243	9
74LS244	9
74LS245	16
74LS247	10
74LS248	10
74LS249	10
74LS251	7
74LS253	7
74LS257	7
74LS258	7
74LS259	12
74LS260	7
74LS261	10
74LS266	6
74LS273	12
74LS275	35
74LS279	7
74LS280	18
74LS283	8
74LS290	8
74LS292	85
74LS293	8
74LS295	14
74LS297	85
74LS298	10
74LS299	22
74LS320	21
74LS323	36
74LS324	15
74LS347	12
74LS348	14
74LS352	11
74LS353	11
74LS356	20
74LS363	15
74LS364	15
74LS365	5
74LS366	5
74LS367	5
74LS368	5
74LS373	10
74LS374	10
74LS375	7
74LS377	13
74LS378	11
74LS379	13
74LS384	40
74LS385	33
74LS386	5
74LS390	8
74LS393	10
74LS395	11
74LS398	15
74LS399	13
74LS447	8
74LS465	14
74LS490	15
74LS540	14
74LS541	14
74LS624	15
74LS629	13
74LS640	2
74LS641	1
74LS645	1
74LS668	
74LS669	
74LS670	1
74LS673	8
74LS674	8
74LS682	2
74LS684	3
74LS687	3

SWITCHES

Toggle: 2 A, 250 V	
SPST	35p
DPDT	48p

SUB-MIN-TOGGLE

SPST on/off	58p
SPDT c/over	64p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	80p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions' on/on/on	185p
I-pole 2 way	220p

SLIDE 250 V:

DPDT 1 A	14p
DPDT 1 A c/off	15p
DPDT ½ A	13p

USHBUTTON
A
vith 10 mm Button

SPDT latching	150p
DPDT latching	200p
SPDT moment	150p
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST SWITCHES
Assorted colours
75p each

DIL SWITCHES

(SPST) 4 way **65p** 6 way **80p**
8 way **85p** 10 way **100p**
(SPDT) 4 way **190p**

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way:
3 pole/2 to 4 way; 4p/2 to 3 way **48p**

ROTARY: Mains: DP 250 V
4 Amp on/off **68p**

ROTARY: (Mak-a-Switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch).
Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way;
3 pole/4 way; 4 pole/3 way;
6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **8p**

ROCKER SWITCHES

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL SWITCH
Mini front mounting

Decade Switch Module	275p
B.C.D. Switch Module	298p
Mounting Cheeks (per pair)	75p

TRANSFORMERS
3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V 100 mA **130p**
pcb mounting. Miniature, Split Bobbin
3VA: 2×6V-0.25A; 2×9V-0.15A; 2×12V-0.12A; 2×15V-0.1A **235p**
6VA: 2×6V-0.5A; 2×9V-0.3A; 2×12V-0.25A; 2×15V-0.2A **280p**
Standard Split Bobbin type:
6VA: 2×6V-0.5A; 2×9V-0.4A; 2×12V-0.3A; 2×15V-0.25A **250p**
12VA: 2×4.5V-1.3A; 2×6V-1A; 2×9V-0.6A; 2×12V-0.5A; 2×15V-0.4A; 2×20V-0.3A **345p** (35p p&p)
24VA: 2×6V-1.5A; 2×9V-1.2A; 2×12V-1A; 2×15V-0.8A; 2×20V-0.6A **385p** (60p p&p)
50VA: 2×6V-4A; 2×9V-2.5A; 2×12V-2A; 2×15V-1.5A; 2×20V-1.2A; 2×25V-1A; 2×30V-0.8A **480p** (60p p&p)
Specially wound for Multirail Computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A **575p** (60p p&p)
100VA: 2×12V-4A; 2×15V-3A; 2×20V-2.5A; 2×25V-2A; 2×30V-1.5A; 2×50V-1A
(20p p&p charge to be added over and above our normal postal charge).

CMOS

		4070	25	4530	90
		4071	25	4531	130
000	20	4072	25	4532	65
001	25	4073	26	4534	400
002	25	4075	25	4536	275
006	75	4076	68	4538	80
007	25	4077	25	4539	90
008	60	4078	25	4541	95
009	45	4081	25	4543	70
010	40	4082	25	4544	150
011	25	4085	60	4548	40
012	25	4086	80	4549	400
013	60	4089	125	4553	246
014	60	4093	37	4554	190
015	60	4094	70	4555	36
016	40	4095	95	4556	55
017	60	4096	100	4557	250
018	60	4097	290	4558	120
019	58	4098	80	4559	396
020	90	4099	110	4560	160
021	58	4160	95	4561	104
022		4161	99	4562	350
023	30	4162	99	4566	165
024	50	4163	99	4568	250
025	22	4174	99	4569	175
026	90	4175	105	4572	45
027	43	4194	105	4580	255
028	45	4408	850	4581	125
029	75	4409	850	4582	99
030	35	4410	725	4583	100
031	130	4411	750	4584	60
032	70	4412	805	4585	60
033	130	4415	590	4597	330
034	140	4419	280	4599	155
035	70	4422	770	40085	90
036	275	4435	860	40097	45
037	115	4440	999	40098	42
038	110	4450	350	40100	215
039	250	4451	350	40101	130
040	60	4490	450	40102	140
041	57	4500	675	40103	412
042	50	4501	38	40104	120
043	42	4502	60	40105	220
044	50	4503	40	40106	60
045	110	4504	99	40107	55
046	60	4505	385	40108	325
047	60	4506	100	40109	80
048	55	4507	45	40110	235
049	38	4508	130	40114	240
050	35	4510	55	40161	194
051	70	4511	55	40163	75
052	60	4512	55	40174	75
053	60	4513	150	40175	75
054	85	4514	115	40181	220
055	85	4515	115	40182	90
056	85	4516	55	40192	75
057	£10	4517	275	40193	70
059	435	4518	48	40194	70
060	68	4519	32	40195	75
061	500	4520	53	40244	196
062	995	4521	115	40245	196
063	86	4522	125	40257	196
066	45	4526	70	40373	220
067	245	4527	85	40374	220
068	25	4528	68	45106	596
069	25	4529	150		

VEROBOARD 0.1 in

	clad	plain
2½ × 3¼	95p	—
2½ × 5″	110p	—
3¾ × 3¾	110p	—
3¾ × 5″	125p	—
3¾ × 17″	420p	198p
4¾ × 17″	590p	275p
Pkt. of 100 pins		55p
Spot face cutter		150p
Pin insertion tool		185p

VQ Board	195p
DIP Board	395p
Vero Strip	95p

PROTO DECs

Veroblock	480p
S-Dec	360p
Eurobreadboard	590p
Bimboard 1	575p
Superstrip SS2	1360p

VERO WIRING

PEN + spool	380p
Spare spool	75p
Combs	6p

DALO ETCH RESIST PEN
Plus spare tip **100p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p P&P

ULTRASONIC TRANSDUCER
40 kHz **395p**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided
6″ × 6″	100p	125p
6″ × 12″	175p	225p

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

EDGE CONNECTORS

2 × 18 way	210p
2 × 22 way	215p
2 × 23 way	175p
2 × 25 way	285p
2 × 28 way	190p
2 × 30 way	310p
2 × 36 way	360p
2 × 40 way	380p
2 × 43 way	450p
2 × 75 way	650p

ANTEX SOLDERING IRON

C-15W	525p	CS17W	550p
G-18W	560p	XS25W	575p

Spare tips, assorted size	85p
Spare Elements	230p
Iron stand with sponge	175p

SIL SOCKET
0.1″ pitch
20 way
65p

VOLTAGE REGULATORS

1A	TO220 type		Plastic ve	Casting
5V	7805	50p	7905	50p
12V	7812	45p	7908	60p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	45p	7918	50p
			7924	50p
100mA	TO92	Plastic		package
5V	78LO5	30p	79LO5	50p
6V	79LO6	30p		
8V	79LO8	30p		
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	50p

ICL7660	248p	TAA550	50p
LM309K	135p	TDA1412	150p
LM317K	250p	78HO5 + 5V/5A	560p
LM317KP	99p	78H12 + 12V/5A	640p
LM323K	450p	78HG + 5V to	+25V
LM337	175p	5 A	585p
LM723 Var	30p	78S40	225
RC4194	375p	79HG 2.25V to	
RC4195	160p	24V 5A	685p

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	45p
500 pins	195p

ALUM BOXES

3 × 2 × 1″	65p
4 × 2½ × 2″	85p
4 × 2¾ × 2½″	103p
4 × 4 × 2″	105p
4 × 4 × 2½″	120p
5 × 4 × 1½″	99p
5 × 4 × 2½″	120p
5 × 2¾ × 1½″	90p
5 × 2¾ × 2½″	130p
6 × 4 × 2″	120p
6 × 4 × 3″	150p
7 × 5 × 3″	180p
8 × 6 × 3″	210p
10 × 4 × 3″	240p
10 × 7 × 3″	275p
12 × 5 × 3″	260p
12 × 8 × 3″	295p

IDC CONNECTORS

PCB Plugs with latch	Pins Strt	Pins Angle	Female Header Plug	Female Card Edge Connect
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	206p	236p	169p	320p
40 way	220p	250p	190p	340p
50 way	236p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

	Female Strt. Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	170p	—	—	175p
DIN41612 2×32 A+B	275p	320p	220p	285p
DIN41612 2×32 A+C	295p	340p	240p	300p
DIN41612 3×32 A+B +C	360p	360p	260p	395p

DIL PLUG
(Header)

	Solder	IDC
14pin	40p	99p
16pin	49p	106p
24pin	88p	178p
28pin	185p	290p
40pin	250p	255p

ZIF TEXTOOL DIL SOCKETS

24 pin	575p
28 pin	695p
40 pin	845p

RIBBON CABLE
price per foot

		Grey	Colour
10 way		15p	28p
16 way		25p	40p
20 way		30p	50p
24 way		40p	65p
28 way		55p	80p
34 way		60p	85p
40 way		70p	90p
50 way		85p	110p
64 way		100p	135p

'D' CONNECTORS miniature

	9 way	15 way	25 way	37 way
MALE				
Solder lugs	80p	105p	160p	250p
Angle pins	150p	210p	250p	365p
PCB pins	120p	130p	195p	295p
FEMALE				
Solder lugs	105p	160p	200p	335p
Angle pins	165p	215p	290p	440p
PCB pins	150p	180p	240p	420p
COVERS	85p	80p	80p	100p
IDC 25way 'D' Plug				385p
Socket				450p

25way 'D' CONNECTOR RS232
Jumper Lead Cable Assembly

18″ long, Single end, Male	495p
18″ long, Single end, Female	525p
36″ long, Double Ended, M/M	1025p
36″ long, Double Ended, F/F	1050p
36″ long, Double Ended, M/F	995p

PANEL METERS
FSD
60×46×35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
475p each

CRYSTALS

32.768KHz	100
100KHz	545
200KHz	370
455KHz	370
1MHz	275
1.008M	275
1.28MHz	450
1.5MHz	525
1.6MHz	595
1.8MHz	545
1.8432M	250
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.194304M	200
4.433619M	100
4.80MHz	200
5.0MHz	180
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0MHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	265
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

RELAYS

Miniature, enclosed, PCB mount.
SINGLE POLE Changeover
RL6-91 205 Ω Coil; 12V DC (10V5 to 19.5 V). 10 A at 30 V DC or 250 V AC **185p**
DOUBLE POLE Changeover. 6 A 30 V DC or 250 V AC
RL6-100 53 Ω Coil, 6 V DC (5V4 to 9V9) **190p**
RL6-111 205 Ω Coil, 12 V DC (10V7 to 19V5) **195p**
RL6-114 740 Ω Coil, 24 V DC (22V to 37 V) **200p**

ASTEC UHF MODULATORS
6 MHz Standard **375p**
8 MHz Wideband **550p**

BUZZERS, miniature, solid state
6V; 9V & 12V **70p**

PIEZO TRANSDUCERS
PB2720 **60p**

LOUDSPEAKERS
Miniature, 0.3W: 8Ω
2in, 3¼in, 2½in, 3in **80p**
2½in, 40Ω, 64Ω or 80Ω **80p**

MONITORS

- ■ Zenith — 12″ Green or amber, Hi-Resolution Popular £68
- ■ MICROVITEC 1431, 14″ Colour RGB input. Connecting Cable incl. £165
- ■ KAGA 12″. Med-Res. RGB. Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc. **£195** (car.7)
- ■ KAGA 12″. As above but Hi-Resolution **£259** (car.7)
- ■ Connecting Lead for KAGA £5
- ■ Carriage **£7** securicor.

BBC MICRO WORD-PROCESSING PACKAGE

A complete wordprocessing package consisting of BBC Micro, Zenith Green Hi-res Monitor, twin cased 200K Disc Drives, Wordwise, Watford's DFS interface, Brother HR15 Daisywheel printer, Database package, 10 Discs, all manuals and cables.

All you require is a mains power point to have it up and running.

Only: £1145

OPTO ELECTRONICS

LEDs with Clips

TL209 Red	10
TIL211 Grn	14
TIL212 Yel.	14
TIL220 .2″ Red	12
.2″ Green, Yellow or Amber	14
0.2″ Bi colour	
Red/Green	100p
Green/Yellow	115p
0.2″ Tri colour	
Red/Green/Yellow	85
Hi-Brightness Red	59
Hi-Bri Green or Yellow	68
Flashing red 0.2″ red	55
Square LEDs, Red, Green, Yellow	45
Rectangle Stackable LEDs	
Red, Green or Yell	18
Triangular LEDs	
Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH, Red 10 segments	275

7 Segment Displays

TIL312 .3″ CA	120
TIL313 .3″ CC	120
TIL321 .5″ CA	140
TIL322 .5″ CC	140
TIL729/730	140
DL704 .3″ CC	125
DL707 .3″ CA	125
FND357 Red	120
FND500	130
.3″ Green CA	150
.6″ Green CA	215
.3″ ± 1 Red CA	150
.3″ ± 1 Green CA	150
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625

NEONS
Rectangular, nut fixing
Red, Amber, Green 30p
REFLECTIVE Optical Switch type TIL139 225p
SLOTTED Optical Switch similar to RS Comp.'s 295p

ISOLATORS

IL74	145
ILD74	145
ILQ74	275
TIL111/2/4	70
TIL117	125
4N33 Photo Darlington	135

OPTO

LS400C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45
BPX25	195
BPW21	295

AMPHENOL CONNECTORS

PLUGS (Male)	IDC	Solder
24 way IEEE	475p	470p
36 way Centronix	525p	475p
24 way Female	490p	450p

COMPUTER CORNER

- ■ EPSON RX80 Printer £209
- ■ EPSON RX80 F/T Printer £219
- ■ EPSON FX80 Printer £316
- ■ EPSON FX100 Printer £429
- ■ KAGA/TAXAN KP810 Printer £242
- ■ KAGA/TAXAN KP910 Printer £339
- ■ SEIKOSHA GP100A Printer £122
- ■ BROTHER HR15 Daisywheel £329
- ■ Cable for above printers to interface with BBC Micro £7
- ■ TEX EPROM ERASER — Erases upto 25 Eproms. Has a built-in safety switch. £30
- ■ SPARE 'UV' lamp bulb £8
- ■ C12 Computer CASSETTES in Library cases 36p
- ■ 8½″ & 9½″ Fan Fold Paper (1000 Sheets) ..... £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)

CUMANA DISK DRIVES (TEC)

(BBC Compatible)

- ■ CS100 — Single Cased with PSU, 40 track, 5¼″ S/S 100K £119
- ■ CD200 — Twin Cased with PSU, 40 track, 5¼″ S/S 200K £236
- ■ Epson Single cased with own PSU D/S, 40 trk, 5¼″, 200K £149

Epson Twin cased with own PSU D/S, 40 trk, 5¼″, 400K... £280

- ■ MITSUBISHI Single Slimline 5¼″ Cased with PSU. DSDD, 1 Megabyte. (400 K with BBC) £165
- ■ MITSUBISHI Twin Slimline, 5¼″ Cased with PSU, DSDD, 2 Megabyte, (800 K with BBC) £339

5¼″ DISKETTES (Lifetime Warranty)

- ■ 10 3M Diskettes Single side Double Density £14
- ■ 10 3M Diskettes Double side Double Density £24

N.B. Carriage on Drives £7 Securicor

SPECTRUM 32K RAM UPGRADE KIT

Upgrade your 16K SPECTRUM to 48K. Full fitting instructions supplied.

ONLY: £22

SPECTRUM CENTRONICS/RS232 PRINTER INTERFACE

- * It was the first! It is still the best!
- * Centronics and BI-DIRECTIONAL RS-232 with full handshaking.
- * Obeys SPECTRUM LLIST and PRINT
- * Split-Speed Operation for RS-232.

(Use it to communicate with the BBC MICRO or OTHER PERIPHERALS)

- * Interface 1, Interface 2 & Microdrive compatible.
- * Configuration program creates customized M/C driver to suit your printer.
- * HI-RES screen dumps in 2 sizes on EPSON, SEIKOSHA, STAR, SHINWA, MANNESMAN TALLY, NEC, RITEMAN, KAGA, etc. This is a STANDARD FEATURE! Not an extra.
- * Compatible with TASWORD TWO and most professional programs.

Only: £29.95

Centronics Parallel Printer Cable £8

BBC MICROCOMPUTER & ACCESSORIES

BBC Micro Model B ...... only £315

We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drivers (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors, (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM, The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEBCALC, Software (Eductional Application & Games), BOOKs, etc, etc,. Please send SAE for our descriptive leaflet.

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

RECHARGEABLE BATTERIES

Dry Fit Maintenance FREE by Sonnenschein. **A300 07191315** 12v 3 AH same as **RS 591-770 NEW £13.95** **A300 07191202** 6-0-6 1.8 AH same as **RS 591-382 EX EQUIP £4.99** Miniature PCB mount 3.6v 100 Mah as **RS 591-477 NEW £1.00** **SAFT VR2C** 1.2v "C" size **NICADS** in 18 cell ex equipment pack. Good condition – easily split to single cells **£10.50** + pp £1.90

EX-STOCK INTEGRATED CIRCUITS

2732 ex equip **£3.25. 27128** – 250ns **NEW £12.00. 6116**-200 **£4.50, 6116**-250 **£3.95, 6264LP**-150 **£22.00. 4164**-200 **£3.50, 4864**-150 **£4.00, 4116**-300, **£1.20, 2114 £1.75. 6800 £2.50, 6821 £1.00, 68A09 £8.00, 68B09 £10.00, 68B09E £14.50, D8085AH-2 £12.00, D8086 £20.00, Z80A £2.99.**

HOT LINE DATA BASE

DISTEL©

THE **ORIGINAL FREE OF CHARGE** dial up data base 1000's of stock items and one off bargains.
ON LINE NOW – 300 baud, full duplex CCITT tones, 8 bit word, no parity.

01-679 1888

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference

SD5A As recommended by **ZX81** news letter, matchbox size up to 1000 watt load ***£5.95***

L2127 compact completely cased unit with 3 pin fitted socket Up to 750 watts ***£9.99***

COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling. Originally made for the famous **DEC PDP8** computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and -15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc etc. Units are in good but used condition – supplied for 240v operation complete with full circuit and tech man **Give your system that professional finish** for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high Useable area 16"w 10.5"h 11.5"d.
Also available **LESS PSU**, with FANS etc. Internal dim. 19"w. 16"d. 10.5"h. ***£19.95***. Carriage & insurance £9.50.

COOLING FANS

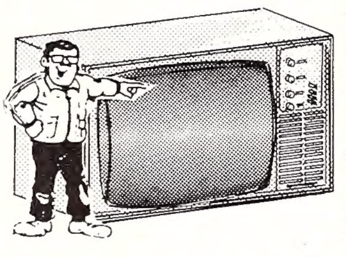
Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.

ETRI 99XUOI Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. **£9.95.**

GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. **NEW £6.95**

BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**

MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60



PRICE BARRIER SHATTERED ON 16" RGB CASED COLOUR MONITORS

A scoop purchase from a major London Hotel enables us to offer this special converted **DECCA 100 COLOUR** video TV at a super low price of **£99.00!!** Low enough to suit any budget!! Solid state modular construction, 16" high definition PIL tube, which eliminates convergence problems and our own special modification results in 80 + column text definition and picture quality not seen on monitors costing three times as much!! In fact we guarantee you will be delighted with this product, the quality has to be seen to be believed. Supplied complete and ready to plug direct to a **BBC MICRO COMPUTER** or any other system with a TTL RGB output. Other features include internal audio amp and speaker, compact dimensions only. 52cm W x 34 H x 24 D, auto degaussing circuit, attractive teak finished case, 30 day guarantee.

ONLY £99.00 + ***£10.00 CARR.***

Also available unmodified complete with mod data (Mod costs less than £12.00) ***£80.00.***

EPROM COPIERS

The amazing **SOFTY 2**. The "Complete Toolkit" for copying, writing, modifying and listing EPROMS of the 2516, 2716, 2532, 2732 range. Many other functions include integral keyboard, cassette interface, serial and parallel data i/o, UHF modulator, ZIF socket etc. ***ONLY £195.00 + PP £2.50.***

"GANG OF EIGHT" intelligent Z80 controlled gang programmer for ALL single 5v rail EPROMS upto 27128. Will copy 8 27128 in typ. ONLY 3 MINUTES!! Internal LCD display and checking routines for IDIOT PROOF operation. ***ONLY £395.00 + PP £3.00.***

"GANG OF EIGHT PLUS" same spec. as above but with additional RS232 serial interface for down line loading data from computer etc. ***ONLY £445.00 + PP £3.00.***

Data sheets on request.

SPECIAL 300 BAUD MODEM OFFER

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DACOM DSL2123 Multi Standard Modem, switchable CCITT or USA BELL 103 standard. V21 300-300, V23 75-1200, V23 1200-75 or 1200-1200 half duplex.
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1nF to 6n8	8p
8n2 to 47nF	9p
56nF to 150 nF	12p

100 V

100nF to 150nF	13p
180nF to 270nF	16p
330nF to 390nF	25p
470nF to 560nF	32p
680nF	38p
1µF (10mm)	40p

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680nF	18p
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10/35V	31p
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15/25V	32p
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22/16V	32p
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47/16V	99p
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ELECTROLYTICS Mainly Panasonic AXIALS (Wires each end)

µFd	V	
.47	63	9p
.47	100	10p
.47	350	35p
1	100	10p
1	500	46p
2.2	25	9p
2.2	63	10p
2.2	100	13p
2.2	350	34p
3.3	40	13p
3.3	63	14p
4.7	35	10p
4.7	50	13p
4.7	63	14p
4.7	100	16p
10	25	9p
10	50	14p
10	63	16p
10	100	18p
10	350	55p
22	25	13p
22	40	16p
22	63	18p
22	100	24p
47	25	16p
47	40	20p
47	63	30p
47	100	32p
100	16	16p
100	25	18p
100	50	25p
100	63	29p
100	100	34p
220	10	18p
220	16	19p
220	25	25p
220	40	29p
220	63	34p
220	100	46p
470	16	25p
470	25	32p
470	40	38p
470	63	50p
470	100	69p
1000	16	34p
1000	25	43p
1000	40	53p
1000	63	75p
2200	16	53p
2200	25	71p
2200	50	80p
2200	63	1.54p
4700	16	87p
4700	25	99p

RADIALS (Wires one end)

µFd	V	
10	35	7p
22	10	7p
22	16	8p
47	10	8p
47	16	9p
100	10	10p
100	16	11p
220	10	13p
220	16	13p
470	10	14p
1000	10	23p
1000	16	28p
2200	10	39p
2200	16	51p
3300	10	57p
3300	16	75p
4700	10	75p
4700	16	1.09p
4700	63	2.99p
10000	16	2.99p
10000	80	4.95p

74TTL

7400	25p
7401	25p
7402	25p
7403	25p
7404	35p
7405	25p
7406	39p
7407	39p
7408	25p
7409	25p
7410	25p
7411	25p
7412	25p
7413	45p
7414	59p
7416	35p
7420	25p
7421	25p
7422	25p
7423	35p
7425	35p
7426	39p
7427	39p
7428	39p
7430	25p
7432	35p
7437	29p
7438	39p
7440	39p
7441	39p
7442	85p
7444	99p
7445	99p
7447	99p
7448	99p
7450	35p
7451	35p
7453	35p
7454	35p
7460	49p
7470	49p
7472	49p
7473	49p
7474	49p
7475	49p
7476	49p
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74132	75p
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74142	2.25
74143	2.25
74144	2.25
74145	99p
74147	1.75
74148	1.29
74150	1.59
74151	65p
74154	1.39
74155	89p
74156	89p
74157	89p
74159	1.75
74160	1.05
74161	1.05
74162	99p
74163	99p
74164	99p
74165	1.05
74166	1.49
74170	1.79
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74173	1.45
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74176	99p
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74182	1.35
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74LS21	24p
74LS22	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	49p
74LS47	85p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73	29p
74LS74	35p
74LS75	45p
74LS76	35p
74LS78	35p
74LS83	69p
74LS85	75p
74LS86	35p
74LS90	49p
74LS92	55p
74LS93	55p
74LS95	75p
74LS107	39p
74LS109	45p
74LS112	45p
74LS113	45p
74LS114	45p
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4044	49p
4045	99p
4045	59p
4047	59p
4049	35p
4050	35p
4051	65p
4052	55p
4053	55p
4054	79p
4056	79p
4059	3.95
4060	65p
4063	85p
4066	39p
4067	2.25
4068	25p
4069	25p
4070	25p
4071	25p
4072	25p
4073	25p
4075	25p
4076	65p
4077	25p
4078	25p
4081	25p
4085	55p
4086	59p
4089	1.19
4093	35p
4094	69p
4095	89p
4096	89p
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4103	1.95
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4507	35p
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4510	49p
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4512	49p
4514	1.04
4515	1.05
4516	55p
4518	45p
4519	29p
4520	49p
4521	1.09
4522	79p
4526	65p
4527	65p
4528	65p
4529	1.25
4532	65p
4534	3.49
4536	2.49
4538	75p
4543	69p
4553	2.39
4555	35p
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4560	1.45
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6821	1.55
6840	3.75
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– Positive – 100mA

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78L12A	29p
78L15A	29p
78L24A	29p

1 Amp TO220

7805T	55p
7812T	55p
7815T	55p
7824T	55p

– Negative – 100mA TO92

79L05	49p
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79L15	49p

1 Amp TO220

7905T	65p
7912T	65p
7915T	65p
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2N2904A	44p
2N2905	44p
2N2905A	48p
2N3053	45p
2N3054	98p
2N3055	65p
2N3055H	1.84p
2N3439	1.44p
2N3440	99p
2N3441	1.55p
2N3442	2.05p
2N3553	2.95p
2N3702	16p
2N3703	16p
2N3704	16p
2N3705	16p
2N3706	16p
2N3707	16p
2N3819	35p
2N3820	69p
2N3866	1.20p
2N3903	13p
2N3904	16p
2N3905	17p
2N3906	15p
2N4036	1.04p
2N4037	1.06p
2N4240	2.78p
2N4400	21p
2N4401	27p
2N4402	26p
2N4427	1.34p
2N4870	99p
2N4871	75p
2N5245	59p
2N5246	68p
2N5247	75p
2N5248	66p
2N5249	67p
2N5296	93p
2N5298	98p
2N5401	45p
2N5415	1.67p
2N5416	1.97p
2N5447	36p
2N5448	36p
2N5449	36p
2N5450	63p
2N5451	66p
2N5457	63p
2N5458	57p
2N5459	63p
2N5460	63p
2N5551	26p
2N5657	2.25p
2N5684	15.10p
2N5884	4.60p
2N5886	4.60p
2N6027	60p
2N6030	9.70p
2N6031	10.90p
2N6058	3.58p
2N6059	3.86p
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BC108A	17p
BC108B	18p
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BC109B	18p
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BC478	38p
BC479	38p
BC546	16p
BC547	19p
BC548	16p
BC549	17p
BC550C	29p
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2 4576MHz	**225p**	10 000MHz	**170p**
3 0000MHz	**240p**	16 000MHz	**190p**
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3 6864MHz	**240p**	19 6608MHz	**240p**
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Z910 139 × 39 mm, this panel has soldered in components — TCA4500A and TBA651R, AM radio with IF amp. Probably complete RF section of radio as IF's and trimmers are on board, + R''s C's etc **£2.50**

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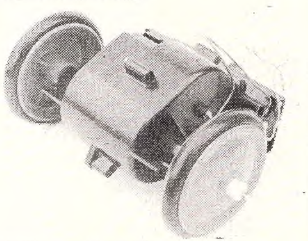

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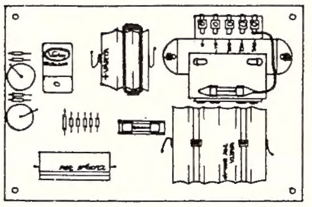

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74LS22	20p
74LS27	20p
74LS28	22p
74LS30	20p
74LS32	20p
74LS33	22p
74LS37	20p
74LS38	20p
74LS42	48p
74LS48	76p
74LS73	26p
74LS74	26p
74LS75	36p
74LS76	26p
74LS78	26p
74LS83	66p
74LS85	73p
74LS86	33p
74LS90	38p
74LS92	33p
74LS93	43p
74LS95	56p
74LS107	42p
74LS109	38p
74LS112	40p
74LS113	30p
74LS123	68p
74LS124	123p
74LS125	35p
74LS126	35p
74LS132	51p
74LS133	48p
74LS138	46p
74LS139	46p
74LS151	53p
74LS153	63p
74LS154	158p
74LS155	53p
74LS156	63p
74LS157	46p
74LS161	58p
74LS163	58p
74LS164	73p
74LS165	93p
74LS166	86p
74LS173	78p
74LS175	58p
74LS181	188p
74LS192	73p
74LS193	75p
74LS197	73p
74LS221	76p
74LS240	78p
74LS241	78p
74LS242	78p
74LS244	78p
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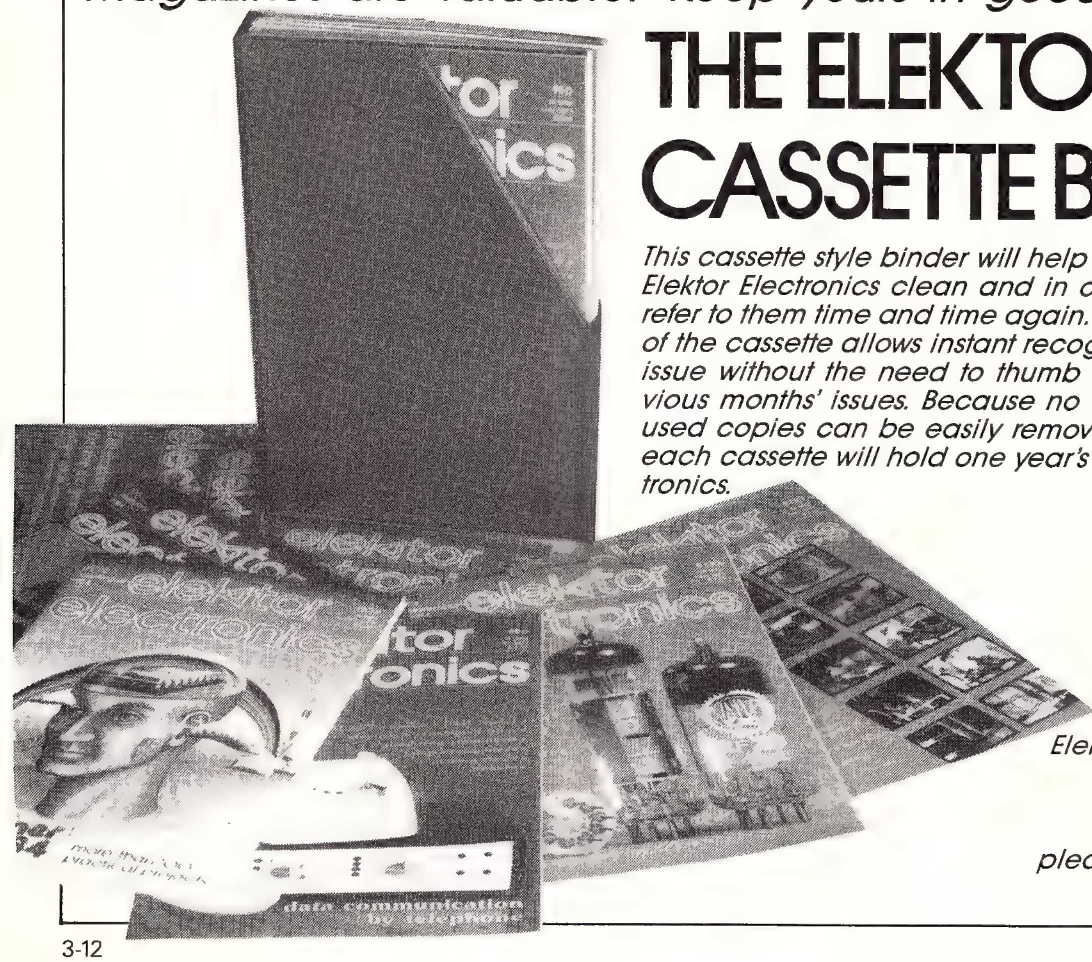

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ECH81	0.75
ECH84	0.75
ECL82	0.75
ECL86	0.98
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EF86	1.60
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EF184	0.75
EH90	0.94
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EL84	0.69
EL509	5.50
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EY86 87	0.67
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PCC84	0.50
PCC85	0.65
PCC89	0.74
PCC189	0.85
PCF80	0.75
PCF86	1.25
PCF200	1.95
PCF801	1.45
PCF802	1.00
PCF806	1 20
PCL82	0.90
PCL83	2.50
PCL84	0.90
PCL86	1.15
PCL805 85	1.35
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PFL200	1.35
PL33	1.50
PL36	1.45
PL81	0.85
PL82	0.75
PL83	0.65
PL84	0 75
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PL508	2.40
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AC141K	0.40
AC142	0.26
AC142K	0.48
AC151	0.45
AC152	0.45
AC176	0.28
AC176K	0 46
AC187	0.42
AC187K	0.48
AC188	0.44
AC188K	0.50
ACY40	0.88
AD142	1.10
AD143	1 10
AD149	0.96
AD161	0.42
AD162	0.42
AD161	
AD162	0.98
AF106	0.48
AF114	2.10
AF115	2.10
AF116	2.10
AF117	2.10
AF118	0.85
AF121	0.62
AF124	0.48
AF125	0.48
AF126	0.48
AF127	0.48
AF139	0.68
AF178	0.68
AF239	0.68
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AL100	2.50
AL102	5.90
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BA102	0.34
BA110	0.67
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BA129	0.38
BA148	0.16
BA154	0.08
BA155	0.10
BA156	0.08
BA157	0.28
BA164	0.14
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BB105B	0.30
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BB110B	0.42
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A or B	0.12

Type	Price (£)
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BC114	0.12
BC115	0.12
BC116	0.15
BC117	0.22
BC118	0.17
BC119	0.30
BC125	0.12
BC140	0.28
BC141	0.42
BC142	0.30
BC143	0.30
BC147	0.08
A or B	0.10
BC148	0.08
A or B	0.10
BC149	0.09
BC157	0.10
BC158	0.10
BC159	0.10
BC160	0.30
BC161	0.30
BC168B	0.12
BC169C	0.10
BC170	0.14
BC170B	0.12
BC171	0.10
A or B	0.08
BC172	0 08
A or B	0.12
BC177	0.20
BC178A	0.22
BC182	0.09
A, B or C	0.09
BC182L	0.09
A, B or C	0.09
BC183	0 09
A, B or C	0.10
BC183L	0.08
A, B or C	0.12
BC184L	0.10
A, B or C	0.10
BC207	0.15
BC208	0.16
BC212	0.09
A, B or C	0.10
BC212L	0.08
A, B or C	0.10
BC213	0.09
A or B	0.10
BC213L	0 10
A or B	0.10
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BC238	0.12
BC239C	0.14
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Type	Price (£)
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BC338	0.12
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BC548	0.12
BC549	0.12
BC550	0.18
BC550C	0.18
BC557	0.12
BC558	0.12
BCX34	0.27
BCY70	0.15
BCY71	0.17
BCY72	0.18
BCZ10	1.68
BCZ11	1.45
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BD132	0.34
BD131 132	0.95
BD135	0.32
BD136	0.36
BD137	0.36
BD138	0.38
BD139	0.38
BD140	0.38
BD144	1.60
BD145	1.82
BD150A	0.51
BD159	0.65
BD160	1 65
BD165	0 45
BD175	0.60
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BD183	1.10
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BD204	0.80
BD222	0.80
BD225	0.86
BD232	0.45
BD233	0.60
BD234	0.62
BD235	0.63
BD236	0.63
BD237	0.65
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BD434	0.68
BD436	0.68
BD437	0.76
BD438	0.75
BD439	0.68
BD507	0.48
BD508	0.53
BD509	0.54
BD510	0.48
BD517	0.56
BD520	0.66
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BD707	0.88
BDX18	2.35
BDX32	2.10
BF115	0.32
BF117	0.54
BF119	0.82
BF120	0.38
BF123	0.40
BF125	0.42
BF127	0.38
BF152	0 16
BF154	0.23
BF157	0.40
BF158	0.22
BF159	0.24
BF160	0.23
BF167	0.30
BF173	0.25
BF177	0.42
BF178	0.30
BF179	0.32
BF180	0 35
BF181	0.35
BF182	0.32
BF183	0.32
BF184	0.32
BF185	0.32
BF194	0 08
BF195	0.10
BF196	0.10
BF197	0.10
BF198	0.14
BF199	0.16
BF200	0.26
BF222	0.48
BF224	0 20
BF224J	0 16
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BF241	0.20
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BF244C	0.24
BF245A	0.28
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BF256	0.40
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BF262	0.30
BF263	0.30
BF270	0.30
BF271	0.26
BF273	0.18
BF274	0.32
BF323	0.92
BF336	0.26
BF337	0.38
BF338	0.38
BF355	0.42
BF363	0.82
BF367	0.24
BF371	0.27
BF422	0.38
BF450	0.38
BF457	0.33
BF458	0.36
BF459	0.44
BFR39	0.22
BFR40	0.22
BFR41	0.22
BFR51	0.30
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BFR62	0.28
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BFX85	0.26
BFX86	0.26
BFX87	0.26
BFX89	0.65
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BFY51	0.21
BFY52	0.21
BFY57	0.40
BFY90	0.90
BFY90S	1.34
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BU104	2.00
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BU108	1.80
BU124	1.75
BU126	1.25
BU133	1.80
BU204	1.35
BU205	1.30
BU206	1.70
BU208	1.55
BU208A	1.63
BU208 02	2.05
BU326S	1 75
BU407	1.65
BU407D	1.80
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BY122	0.68
BY126	0.12
BY127	0.10
BY133	0.16
BY135	0.25
BY164	0.44
BY179	0.66
BY182	0.87
BY184	0.40
BY187	0.72
BY189	4.75
BY198	0.44
BY199	0.47
BY206	0.24
BY207	0.24
BY210 400	0.25
BY210/600	0.26
BY210/800	0.30
BY223	1.20
BY227	0.26
BY229	0.30
BY238	0.68
BYX10	0.24

Type	Price (£)
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BYX36/600	0.28
BYX48/300	0.72
BYX49/300	0.47
BYX55 350	0.29
BYX55/600	0.33
BYX71/600	1.18
BYZ12	0.42
C106D	0.80
E1222	0.40
E5024	0.30
GET872	0.48
ITT44	0.04
ITT2002	0.11
ME0402	0.20
ME0404/2	0.24
MEU21	0.60
MJ400	1.25
MJ2955	0.90
MJ3000	1.98
MJE240	0.60
MJE340	0.54
MJE370	0.88
MJE520	0.48
MJE2955	0.99
MJE3055	0 70
MPSL01	0.28
OA47	0.10
OA90	0.08
OA91	0.09
OA95	0.18
OA200	0.06
OA202	0.15
OC25	2 10
OC26	1.70
OC28	1.50
OC29	2.47
OC35	1.75
OC36	1.75
OC42	0.72
OC42K	1.40
OC44	0.72
OC45	0.58
OC71	0.50
OC72	0.52
OC81	0.68
OC200	2.46
OC202	2.20
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TIC47	0.70
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TIP42A	0.52
TIP47	0.60
TIP110	0.88
TIP2955	0.60
TIP3055	0.60
TIS43	0.88
TIS88	0 40
TIS90	0.25
TIS91	0.28
ZTX108	0.12
ZTX109	0.12
ZTX212	0.28
1N4001	0.05
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1N4004	0.06
1N4006	0.07
1N4007	0.07
1N4148	0.05
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1N5405	0.16
1N5406	0.18
1N5408	0.20
1S920	0.08
2N697	0.55
2N706A	0.33
2N2904	0.28
2N2906	0.24
2N2926G	0.10
2N3053	0.40
2N3054	0.56
2N3055	0.45
2N3702	0.10
2N3704	0.10
2N3708	0.10
2N3772	1.90
2N3773	2.70
2N3904	0.16
2N3906	0.16
2N5294	0.48
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2SC1306	0.92
2SC1307	1.40
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2SC1507	0.63
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2SC1758	0.68
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2SC1957	0.76
2SC1969	2.88
2SC2028	0.73
2SC2029	2.10
2SC2078	1.05
2SC2091	0.73
2SC2098	2.90
2SC2122A	3.20
2SC2166	1 20
2SC2314	0.80
2SC2335	1.50
2SC2749	2 70
2SC2752	0.60
2SD234	0.64
2SD348	3.30
2SD986	0.62
2SK134	3.80
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MC1310P	1.85
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MC1330P	0.83
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MC1350P	1.20
MC1351P	2.50
MC1352P	1 50
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SN76013N	1.90
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SN76033N	2.45
SN76110N	1.12
SN76115N	2.00
SN76131N	1.65
SN76226DN	1.80
SN76227N	1.10

SN76530P	1.40
SN76533N	1.60
SN76650N	1 05
SN76660N	0.75
SN76666N	0.80
STK015	6.50
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TA7120P	2.20
TA7129AP	3.65
TA7130P	1.65
TA7172	1.80
TA7193	5.50
TA7172P	1.80
TA7176	2.50
TA7202P	4 18
TA7204P	1.86
TA7205AP	1.50
TA7208P	3.27
TA7210P	6.50
TA7222P	2.12
TA7223P	3.68
TA7227P	5.60
TA7310P	1.80
TAA263	2.46
TAA310A	2.68
TAA550	0.50
TAA570	1.99
TAA611A12	3.50
TAA630S	3.90
TAA661B	1.70
TAA700	2.80
TAA840	3.38
TAD100	2.80
FM FILTER	1.20
TBA120 AS,	
S,SA,SB	1.30
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TBA120B	1.30
TBA231	1.45
TBA281	2.65
TBA395	1.20
TBA480Q	1.50
TBA400	2.30
TBA510	2.60
TBA510Q	2.60
TBA520/Q	1.60
TBA530/Q	1.30
TBA540/Q	1.40
TBA550/Q	1.52
TBA560C	1.70
TBA560CQ	1.60
TBA570	1.50

TBA641BX1	4.50
TBA673	2.40
TBA700	2 85
TBA750	2 80
TBA800	1.60
TBA810P	1 10
TBA810S	1.20
TBA820	1.60
TBA890	3.88
TBA920/Q	3.00
TBA950/2A	3.05
TBA970	4.05
TBA990	1.88
TCA160C	3 90
TCA270S	4.00
TCA270SA	4 02
TCA800	3 10
TCA940	1.90
TDA440	3 80
TDA1002	1.90
TDA1003A	5.50
TDA1004A	3.75
TDA1006A	2.40
TDA1035S	4 50
TDA1044	4.30
TDA1170S	3.00
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TDA1200	2.98
TDA1270Q	3.70
TDA1327A	1.66
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TDA1412	1.20
TDA2002	2.80
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TDA2030	2.78
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UPC1018C	1.10
UPC1025H	2.90
UPC1032H	0.90
UPC1156H	4.20
UPC1158H	0.76
UPC1163H	0.98

UPC1181H	1.60
UPC1185H2	3.75
UPC1212C	1.30
UPC1230H	3.90
UPC1350C	4 25
UPC1367C	3.40
UPC1378H	4.40
UPC2002H	2.80

SOLDERING SECTION

XS25W Iron kit, complete with stand & plug attached	8.20
CS18W as above	8.00
Antex 15W iron	5.00
Antex 18W iron	5.00
Antex 25W iron	5.20
Antex elements	2.00
Antex bits	0.95
Antex stands	1.90
Soldersucker	4.50
Spare nozzles for Soldersucker	0.65

SERVICE AIDS

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Switch Cleaner	0.88
Circuit Freezer	0.96
Foam Cleanser	0.84
Aero Klene	0.78
Silicone Grease (Aerosol)	1.00
Antistatic Spray	0.82
Plastic Seal	0.88
Excel Polish	0.76
Fire Extinguisher 640g	2.80
Video Head Cleaner	0.88
Silicone Grease (IC1) 75g	1.50
Solda Mop (Std)	0.72
Solda Mop (L/Gauge)	0.72

Additional P&P on above 30p each

PRESETS

0.25W Type
100R-4m7 V&H
10p each,
0/90p
0.1W Type
100R-1M V&H
7p each,
10/65p

PLUGS & SOCKETS

Metal Co-ax Plug	0.18
Plastic Co-ax Plug	0.14
Metal Line Socket	0.32
Single Junction Socket	0.80
Plastic Phono	0.10
F.M. Plugs	0.20
PL259 Plugs	0.38
Reducer	0.15

Fuseholders

20mm Panel Mounting	0.28
20mm Chassis Mounting	0 06
1¼" Panel Mounting	0 35
1¼" Chassis Mounting	0 12
Carline 1¼" holder	0.10

TELEPHONE SPECIAL

B T App Telephone Plug + 3m Lead	£1.25
B T App Master Socket - incl Wiring Instructions	£2.85
B T App Secondary Socket	£1.95

CHART RECORDER SPECIAL

Brand new 3 channel pen recorders complete with charts Full spec upon request once only price **£40 + £10 p&p + VAT.**

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Universal Ni-Cad Charger charges PP3,AA,C,D
Price £6.00

RECHARGEABLE	BATTERIES
AA (HP7)	.85 ea.
	10/75p ea.
C (HP11)	1.75 ea.
	10/1.65 ea.
D (HP2)	2.05 ea.
	10/1.95 ea.
PP3	3.80 ea.
	10/3.70 ea.

I.C. SOCKETS

Dil to Dil		
8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
16 pin	0.11	1.00/10
18 pin	0.14	1.60/10
22 pin	0.21	1.95/10
24 pin	0.25	2.25/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

FUSES Prices per 10

1¼" Quick Blow. 100, 150, 250mA **£1.30.** 1, 1 25, 1 5, 2, 2 5, 3, 10, 15A **55p. 1¼" Time Delay.** 100mA **£3.50.** 150mA **£2.25** 250, 300, 500, 600, 750, 850mA **£1.84** 1, 1.25, 1 5, 1.6, 2A **£1 84.** 2 5A, 3.15, 3, 5A **£2.82. 20mm Quick Blow** 100, 125, 160, 200, 250, 315, 400, 500, 630, 800mA, 1, 1.25, 1 6, 2, 2.5, 3.15, 4, 5, 6 3A. **40p. 20mm Time Delay.** 100, 125, 160, 200mA **£1.80.** 250, 315, 400, 500, 630, 800mA. **£1.00.** 1, 1.25, 1 6, 2, 2 5, 3 15, 4, 5, 6.3A **85p. 1" Mains.** 2, 3, 5, 7, 10, 13A **85p**

Manufacturers please note — we can offer very competitive prices for production quantities of 20 mm Q/Blow and T/Delay range — apply for quotation.

MICRO

2764-250n/s	£5.80
Z80A-CPU	£3.70
Z80A-CTC	£3.30
Z80-ADNA	9.00
Z80-AP10	3.40
Z80-AS10/0	8.75
Z80-AS10/2	8.99

4000	24p	4052	60p	4510	55p
4001	24p	4053	60p	4511	55p
4002	25p	4066	45p	4512	55p
4007	25p	4067	2.45p	4513	55p
4011	24p	4068	24p	4514	1.15p
4012	24p	4069	24p	4515	1.15p
4013	56p	4070	25p	4516	55p
4014	60p	4071	24p	4517	2.70p
4015	60p	4072	25p	4518	48p
4016	40p	4073	25p	4520	53p
4017	60p	4075	25p	4521	1.15p
4018	60p	4076	68p	4522	1.25p
4020	85p	4077	25p	4526	60p
4021	58p	4078	25p	4528	68p
4022	96p	4081	25p	4531	1.30p
4023	35p	4082	25p	4532	65p
4024	50p	4085	58p	4536	2.65p
4025	24p	4086	58p	4538	80p
4027	45p	4089	1.25p	4539	90p
4028	45p	4093	37p	4541	90p
4029	75p	4094	95p	4543	1.25p
4030	35p	4095	95p	4549	4.00p
4031	1.30p	4096	99p	4553	2.45p
4033	1.25p	4097	2.65p	4554	1.92p
4034	1 46p	4098	80p	4555	35p
4035	70p	4099	1.05p	4556	55p
4036A	2.75p	4161	96p	4557	2.50p
4038	75p	4162	96p	4558	1.20p
4039A	2.80P	4163	96p	4559	3 25p
4040	60p	4174	96p	4560	1.80p
4042	50p	4175	1.00p	4562	3.50p
4043	42p	4194	99p	4566	1 75p
4044	50p	4501	38p	4569	1.95p
4046	60p	4502	38p	4583	1.05p
4049	38p	4503	40p	4584	55p
4050	36p	4507	48p	4585	70p
4051	70p	4508	1.30p	4724	1.10p

VEROBOARD

0.1in.Clad.	
2½ x 3¾"	85p
2½ x 5"	1.00
3¾ x 3¾"	1.05
3¾ x 5"	1.15
2½ x 17"	3.25
3¾ x 17"	4.10
4¾ x 17¾"	4.95
Pkt.of 100 pins	.50
Spot face cutter	1.48
Pin insert.tool	1.83
Vero Wiring Pen + spool	3.50

VEROBOARD

0.1in.PLAIN.	
3¾ x 5"	.95
3¾ x 17"	2.70
DIP Board	3.85
Vero Strip	1.25
HAND HELP CONTROL BOXES	.75

TERMINAL BLOCKS

2 amp 12 way	.19
5 amp 12 way	.20
15 amp 12 way	.46
32 amp 12 way	.92

RESISTORS – CARBON FILM 5%

¼W 1RO to 10M (E12 Range)	**2p each. 15p/10. 75p/100**
¼W 2R2 to 10M (E24 Range)	**2p each. 15p/10. 75p/100**
1W 10R to 2M2 (E12 Range)	**7p each. 65p/10. 6.00/100**
2W 10R to 2M2 (E6 Range)	**8p each. 70p/10. 6.00/100**

RESISTOR KITS – each value individually packed

¼W pack 10 each value E12 – 10R to 1M 610 pieces	5.00
¼W pack 5 each value E12 – 10R to 1M 305 pieces	3.00
½W pack 10 each value E12 – 2R2 to 2M2 730 pieces	6.00
½W pack 5 each value E12 – 2R2 to 2M2 365 pieces	3.50
1W pack 5 each value E12 – 2R2 to 1M 353 pieces	15.00
2W pack 5 each value E6 – 10R to 2M2 317 pieces	18.00

RESISTORS – WIREWOUND Generally 5%

2.5W – 0.22 to 270R – Available in preferred values	0.20
4W – 1R0 to 10K – Available in preferred values	0.21
7W – 0.47R to 22K – Available in preferred values	0.25
11W – 1R0 to 22K – Available in preferred values	0.29
17W –1R0 to 22K – Available in preferred values	0.37

Potentiometers

Carbon Track, Rotary 0.25 W Log & Lin values. All ¼" Spindle, 20 ml body dia, Shaft 2' long.

4K7 — 2M2 Single Gang Log	.32	10/£3.00
1K — 2M2 Single Gang Lin.	.32	10/£3.00
5K — 2M2 Single Gang DP Switch Log . . .	.75	10/£7.00
5K — 2M2 Double Gang Log & Lin	.86	10/£8.25

MIN. "D" CONNECTORS.

		9way	15way	25way	37way
PLUGS	Solder Lug	.52	.65	.88	1.45
	R. Angle	.89	1.34	1.98	3.48
SOCKETS	Solder Lug	.78	.98	1.33	2.48
	R. Angle	1.18	1.78	2.70	4.15
COVERS		.95	.95	.98	1.00

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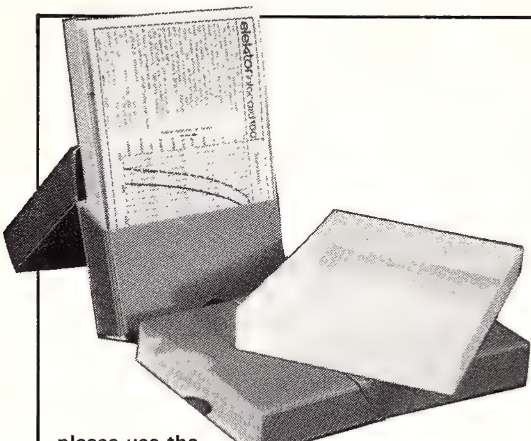

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infocards

Over the last three years, the Infocards published in Elektor have become an essential part of the magazine to many readers. Each card is crammed full of invaluable information on topics related to electronics and ranging from copper wire to interference suppression and from resistor colour coding to microprocessor ICs. Following numerous requests for reprints, we are now making available the set of Infocards 1 to 99, complete with two index cards to simplify locating any card or subject. Get them now while they are hot off the presses and have a mine of information at your fingertips.
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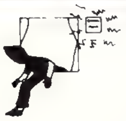
ELECTRONIC SIREN KIT

Produces an extremely loud piercing swept frequency tone from a 9-15V supply. Enable input for easy connection to alarm circuits. Includes 5in. Horn Speaker **£7.90**

Mini Siren
As above, but with a small speaker (instead of horn speaker) for internal use. Complete with box **£4.30**

SECURITY PRODUCTS



Protect your home and property and save by building your own burglar alarm system.

Stair Mat 23 × 7 in (950 120)	£1.70
Floor Mat 29 × 16 in (950 125)	£2.60
Tamper-proof connecting block (950 110)	£0.30
Door/Window Contacts. Flush mounting, 4 wire, Magnet/switch Per Pair. (950 140)	£1.05
Window Tape 0 5'' wide 50m (950 145)	£2.50
Window Tape Terminations Per pair. (950 150)	£0.36
Key-operated Switch. 1 5A 250V SPST Heavy chrome metal (350 128)	£4.50

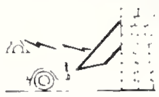
Passive Infra-Red Detector
Detects intruder's body heat Range 10 metres 12V DC, n/o & n/c contact. (950 135) **£40.00**

Alarm Control Unit. 4 input circuits, 2 instant and 2-delayed. Adjustable entry, exit and alarm times. Built and tested Full instructions supplied. Size: 180 × 130 × 30mm. Supply: 12V DC (950 160) **£26.00**

Ultrasonic Burglar Alarm. Self-contained mains or battery powered unit complete with horn and AC adaptor. Imputs for pressure mats and other sensors together with exit/entry delays enable this unit to be used as a complete system. **£45.00** + p&p £2.20

8W Horn Speaker. 5 5 ins. 8 ohm. Ideal for sirens, etc 2.5m lead and 3.5mm jack plug (403 148) **£6.15**

IR GARAGE DOOR CONTROLLER KIT



For controlling motorised garage doors and switching garage and drive lights on off up to a range of 40 ft

Lots of applications like controlling lights and TVs, etc. in the home Ideal for aged or disabled persons. this coded kit comprises of a mains powered infra red receiver with a normally open relay output plus two latched transistor outputs, battery powered transmitter and opto isolated solid state mains switch

XK103		£25.00
XK105	Extra transmitters	£10.50

PANTEC KITS

PN2	FM Micro Transmitter	**£7.50**
PN3	Stabilised Power Supply	**£13 70**
PN5	2 × 10w Stereo Amplifier	**£14.50**
PN6	2 × 40w Stereo Amplifier	**£24.95**
PN7	Pushbutton Stereo Preamp	**£12.80**
PN8	Tone & Volume Control	**£13.60**
PN11	3w FM Transmitter	**£11.95**
PN13	Single Channel FM Transmitter	**£9.80**
PN14	Receiver for above	**£15.50**

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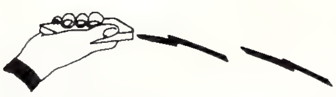
INFRA-RED REMOTE CONTROL KITS



These kits are designed to enable infra red remote control to be incorporated into virtually any application from switching car locks or alarms to controlling Hi-Fi or TV. The application will determine the interface circuitry between the receiver and the controlled device. General instructions and applications are supplied The kits are coded and provide a high degree of security and noise immunity

MK 18 Transmitter Kit — for use with MK11/MK12 receivers Requires PP3 battery Size: 8 × 2 × 13cms Range approx. 60 ft. **£6.80**

Keyboards for MK18

MK9 4-way for use with MK12	**£1.90**
MK10 16-way for use with MK12	**£5.40**
MK13 11-way for use with MK11	**£4.35**

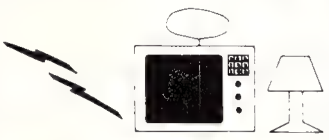
MK11 Receiver Kit mains powered Provides 10 latched plus 3 analogue outputs ideal for controlling audio amplifiers. TV or lighting where control of light brightness is required **£13.50**

MK14 AC Power Controller Kit for (phase) controlling AC loads from MK11 analogue outputs, eg lamp dimming **£5.20**

MK19 Stereo Amplifier Controller Kit for remote control of bass, treble and volume (or balance) by MKII. Includes a one of 10 decoder remote channel or input selection. May be connected between the pre-amp and power amp of almost any audio system. **£10.70**

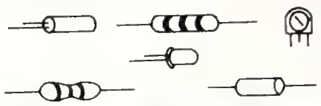
MK12 Receiver Kit mains powered with 16 latched or momentary outputs Latched version is for applications requiring one output on at a time, eg TV channel selection. Momentary type gives an output only during transmission Lines may be latched as required
Size: 9 × 4 × 2cms. **£13.50**

MK15 Dual Latched Solid State Relay for switching mains loads such as lamps, TVs, etc, from the outputs of the MK12 (momentary). 15 items may be switched independently using 8 MK15s Triacs (not supplied) switch at mains zero to reduce interference **£4.50**



COMPONENT PACKS

PACK 1	650 Resistors 47R 10M 10 per value	£4 00
PACK 2	40 · 16V Electrolytics 10 1000μF 5 per value	£3 25
PACK 3	60 · Polyester Capacitors 0.01 1μF 250V 5 values	£5 55
PACK 4	45 Presets 100R 1M	£3.00
PACK 5	30 · Low Profile IC Sockets 8 14 & 16 pin	£2.40
PACK 6	25 Red LEDs (5mm)	£1 75



BT STYLE PHONE CONNECTORS

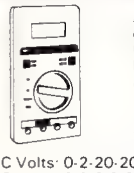
Line Jack Units
Master Unit (first line unit) has bell capacitor and surge arrester
Flush or surface mounting Screw connectors

Master (flush)	(960 110)	**£3 00**
Master (surface)	(960 112)	**£3 00**
Master (mini surface)	(960 113)	**£3.50**
Secondary (flush)	(960 114)	**£2 65**
Secondary (surface)	(960 116)	**£2.65**
Secondary (mini surf)	(960 117)	**£3 00**
Dual outlet adaptor	(960 118)	**£4.20**
4-way line cord with plug to spade terminals	(960 120)	**£2 00**
4-way line cord	(960 130)	**£0.20 per m**

LCD DIGITAL MULTIMETERS

LOW COST! 10M ohm. 3½ digit 0.4 in display. Auto zero and polarity, low batt indication, overload protection. Includes test leads, battery, spare fuse, manual, carrying case.
AC Volts: 0 — 200 - 500.
DC Volts: 0-2-20-200-1000
DC Current: 0-20m-200mA.
Resistance: 0-2k 20k 200k-2M.
Size: 138 × 86 × 36mm.
(405 202) **£25.95**

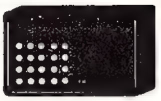
Professional — 10M, 0.5 in, 3½ digit. Overrange and low battery indication. Overload protection. Includes leads, spare fuse, battery, manual and case. Transistor Checker. Size: 175 × 93 × 42mm.
AC Volts: 0-200-750.
DC Volts: 0-200m-2-20-200-1000.
DC Current: 0-20u-2m 20m-200mA. 0-10A
Ohms: 0-200-2k-20k-200k-2M. 0-20M.
(405 204) **£33.50**



Auto Ranging. 3½ digit 10mm display. Continuity buzzer, low battery, overload and range indication. 10A internal shunt for AC/DC current measurement Carrying case supplied.
AC Volts: 0-2-20-200-600.
DC Volts: 0-0.2-2 20-200-1000
AC Current: 0-200mA. 0-10A.
DC Current: 0-200mA/0-10A.
Resistance: 0-200-2k-20k-200k. 0-2M.
Size: 160 × 85 × 29mm.
(405 206) **£44.85**

High Sensitivity Temperature Probe. For use with a multimeter to measure temperatures from −50°C to +250°C. Accuracy: 1.5°C@25°C, 2°C@100°C. Response time (in water), 5 seconds. Includes case, calibrated scale and instructions. (405 220) **£8.50**

MICROPROCESSOR TIMER KIT



Designed to control 4 outputs independently switching on and off at preset times over a 7-day cycle. LED display of time and day, easily programmed via 20-way keyboard Ideal for central heating control (including different switching times for weekends). Battery back-up circuit. Includes box.
18 time settings.

CT6000K **£39.00**

XK114. Relay Kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts **£3 90**

701 115 Additional Relays **£1.65**

ELECTRONIC LOCK KIT

With hundreds of uses indoors, garages, car anti-theft devices, electronic equipment, etc. Only the correct easily changed four-digit code will open it! Requires a 5-15V DC supply. Output 750mA. Fits into standard electrical wall box.
Complete kit (except front panel)
XK101 **£11.50**

Electric Lock Mechanism for use with existing door locks and the above kit. (Requires relay.) 12V AC/DC coil. (701 150) **£14.95**

HOME LIGHTING KITS

These kits are designed to replace a standard wall switch to control up to 300w of lighting

TDR300K	Remote Controlled Light Dimmer	£14.95
MK6	Transmitter for above	£4.50
TD300K	Touch Dimmer	£7.75
TS300K	Touch Switch	£7.75
TDE/K	2 way extension for above kits	£2.50
LD300K	Rotary controlled Light Dimmer	£3.95

DISCO LIGHTING KITS

DL1000K This value-for-money 4-way chaser features bi-directional sequence and dimming. 1kW per channel. **£15.95**

DLZ1000K A lower cost uni directional version of the above. Zero switching to reduce interference. **£8.95**

Optional opto input allowing audio 'beat', light response **(DLA/1)** **70p**

DL3000K 3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. **£12.95**

DVM/ULTRA SENSITIVE THERMOMETER KIT

Based on the ICL 7126 and a 3½ digit liquid crystal display, this kit will form the basis of a digital multimeter (only a few additional resistors and switches are required — details supplied), or a sensitive digital thermometer (50°C to +150°C) reading 0.1°C. The kit has a sensitivity of 200mV for a full-scale leading automatic polarity and overload indication. Typical battery life of 2 years (PP3). **£15.50**

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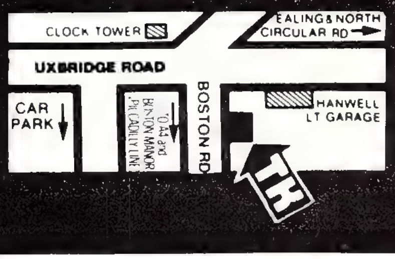
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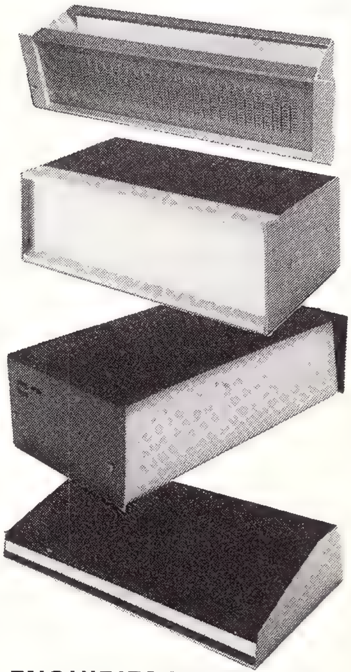

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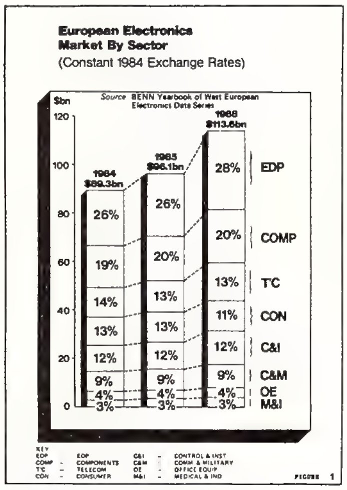
Forecasting Europe's electronic future

The European electronics market is set to expand by around 7.5 per cent in real terms in 1985, compared with 1984, according to the 12th edition of Benn's Yearbook of West European Electronics Data, the industry's leading handbook.

In 1985 the total West European electronics market for equipment and components will reach $96 billion ($10^9$) at constant 1983 values, compared with $89.3 billion ($10^9$) in 1984, and is forecast to reach $114 billion in constant terms by 1988, an annual average growth rate 1985-88 of 5.75 per cent in real terms (figure 1).


European Electronics Market By Sector
(Constant 1984 Exchange Rates)

Source BENN Yearbook of West European Electronics Data Series

FIGURE 1

The yearbook cites a slowdown in West European economic growth beyond 1985 as the reason for the relatively low growth rates 1985-88, as Europe follows the USA into an economic downturn (on preset consensus forecasts) in 1986.

Particularly slow moving sectors in the 1985-88 period will be the Office Electronic Equipment market, projected to grow at an annual average growth rate of 2.5 per cent 1985-88, and the Consumer Electronics market, where only 1.5 per cent per annum real growth is expected 1985-88.

Fastest growing sector will be Electronic Data Processing (including computers, personal computers, word processing systems, and computer peripherals) which can enjoy a market growth rate of 8.25 per cent per annum in real terms 1985-88, taking the total European EDP market to $32 billion in 1988.

The second largest European equipment market, for Telecommunications equipment, will reach some $15.3 billion by 1988, assuming growth in the order of 6 per cent per annum over the period 1985-88.

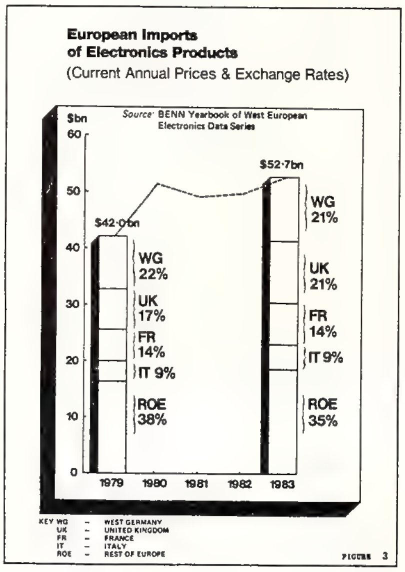
The overall component market, including active, passive and audio components is also projected to expand at 6 per cent per annum 1985-88, taking the combined total to $22.3 billion in 1988. Within the component sector, integrated circuits and other microcircuits are expected to maintain a growth rate of little more than 9.5 per cent per annum in real terms for the 1985-88 period, taking the total IC market (including hybrids) to approximately $4.9 billion in 1988, after $3.8 billion in 1985, for Europe as a whole. The IC market (including hybrids) is projected to grow by almost 15.5 per cent in 1985 compared with 1984, when the market is estimated at $3.27 billion.

Other major sectors covered in the yearbook include Control and Instrumentation, expected to expand at some 5.9 per cent per annum 1985-88, Communications and Military equipment, growing at a rate of 5.75 per cent in real terms 1985-88, and Medical and Industrial Electronic Equipment, a sector which is forecast to increase at a rate of approximately 5 per cent per annum over 1985-88 period.

In national terms, the most surprising feature is the rise of the United Kingdom market to vie with that of West Germany in size as the largest electronics market in Europe, by 1988, when the UK market will be approximately $25.5 billion in total and West Germany $25.6 billion, each market representing some 22.5 per cent of the European total (figure 2).

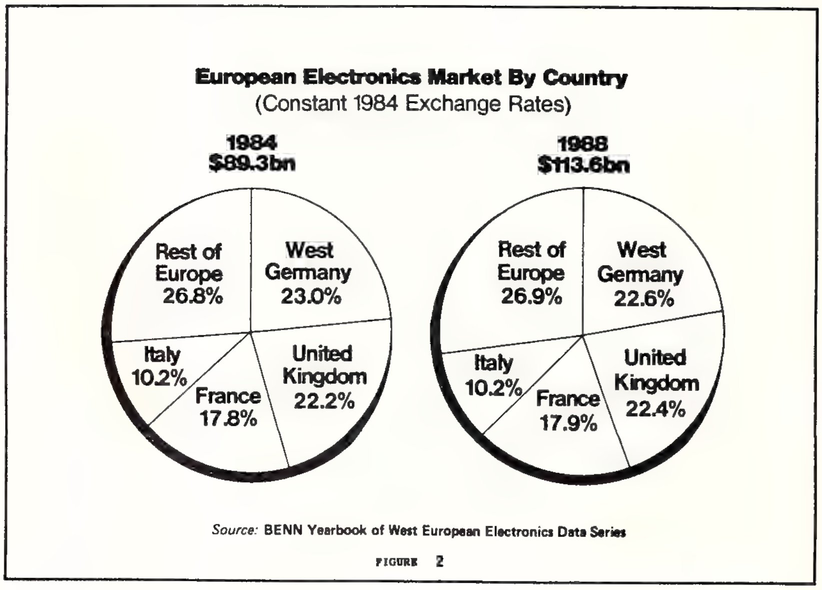
A prime factor in the faster growth of the UK market at 6 per cent per annum over the period 1985-88, compared with 5.25 per cent per annum in the FRG, will be the surge in the UK EDP market, which is projected to overtake the German market in size in real terms by 1988, when the UK EDP market will be $6.8 billion, compared with $6.6 billion in the FRG; in 1984 the respective totals are estimated as $4.5 billion in the UK and $4.9 billion in FRG.

However there are strong indications


European Imports of Electronics Products
(Current Annual Prices & Exchange Rates)

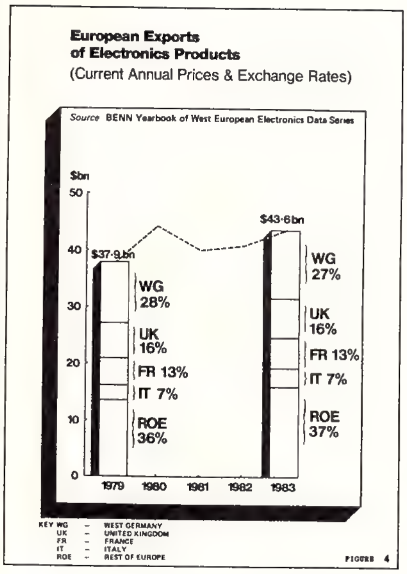
Source: BENN Yearbook of West European Electronics Data Series

FIGURE 3


European Electronics Market By Country
(Constant 1984 Exchange Rates)

Source: BENN Yearbook of West European Electronics Data Series

FIGURE 2



European Exports of Electronics Products
(Current Annual Prices & Exchange Rates)

Source BENN Yearbook of West European Electronics Data Series

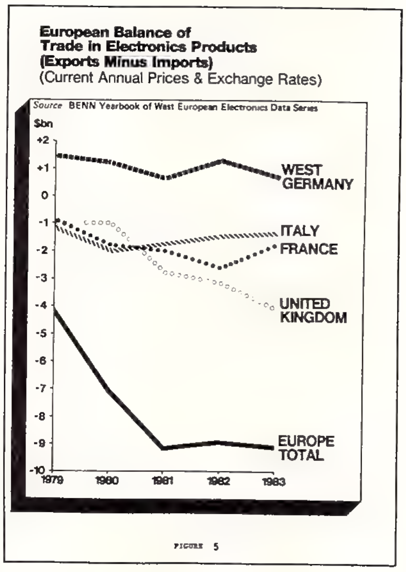
KEY WG – WEST GERMANY
UK – UNITED KINGDOM
FR – FRANCE
IT – ITALY
ROE – REST OF EUROPE

FIGURE 4

that British manufacturers may not benefit from this UK market growth to the same extent as importers. An analysis of data from the new and previous editions of the yearbook series shows that imports of electronics equipment and components have grown at a much faster rate than output in the UK over the five year period 1979-83 and reveals an alarming increase in the UK trade deficit in electronics goods compared with other European countries.

At current annual prices and exchange rates UK imports in the Electronics sector represented 17 per cent of total European imports of electronics goods in 1979, but had increased to 21 per cent of total European electronics imports by 1983 (figure 3). In contrast, the UK's share of European Exports of electronics products remained static over the 1979-83 period, at approximately 16 per cent of European total Exports (figure 4), valued at $6.1 billion in 1979 and $7.0 billion in 1983.

Even more alarmingly, the UK trade deficit in the Electronics sector increased from $1 billion in 1979 representing 25 per cent of the total European electronics trade deficit, to $4.1 billion in 1983 (the latest available complete year) representing over 45 per cent of the total European trade deficit in electronics of $9.1 billion in 1983 (figure 5).



European Balance of Trade in Electronics Products (Exports Minus Imports)
(Current Annual Prices & Exchange Rates)

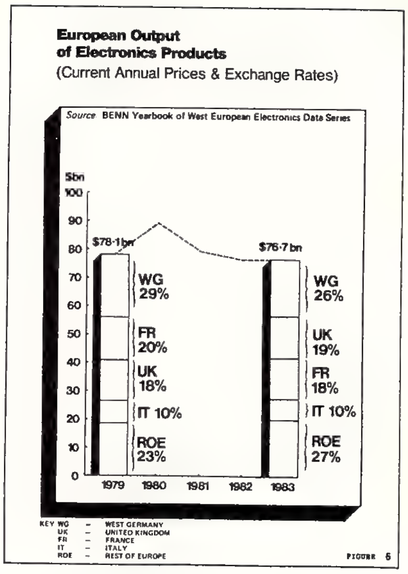
Source BENN Yearbook of West European Electronics Data Series

FIGURE 5

Comparative data for other major European countries shows that West Germany reduced its import penetration as a percentage of the European electronics total from 22 per cent in 1979 to 21.3 per cent in 1983 and has run a trade surplus in electronics products throughout the whole period 1979-83 inclusive, although this reduced from a surplus of $1.5 billion in 1979 to a surplus of $0.7 billion in 1983.

France reduced its electronics trading deficit from 20.7 per cent of the European total in 1979 to 19.6 per cent of the European total in 1983, although in value terms the deficit more than doubled from $0.8 billion in 1979 to $1.8 billion in 1983, at current prices and exchange rates.

The most improved trading performance was achieved by Italy, however, which reduced its electronics trading deficit from over 28 per cent of the European total electronics trading deficit in 1979 (at $1.2 billion) to under 15 per cent of the European total electronics deficit in 1983 (at $1.3 billion deficit in 1983).



European Output of Electronics Products
(Current Annual Prices & Exchange Rates)

Source BENN Yearbook of West European Electronics Data Series

KEY WG – WEST GERMANY
UK – UNITED KINGDOM
FR – FRANCE
IT – ITALY
ROE – REST OF EUROPE

FIGURE 6

In output terms (figure 6), the UK fared slightly better over the 1979-83 period, improving its production of electronics equipment and components from 17.7 per cent of the European total in 1979 to 19.2 per cent in 1983. The FRG share of total European electronics production fell from 28.2 per cent in 1979 to 26.2 per cent in 1983 and the French share fell from 19.8 per cent in 1979 to 18.5 per cent in 1983; Italy maintained its share of European electronics output at approximately 10 per cent of the total in 1979 and 1983 (all values at current prices and exchange rates per annum).

NEWS
VIEWS
PEOPLE

This is the end of our broadcasts...

A milestone in the history of British broadcasting was reached last January when all of the remaining BBC 405-line (vhf) transmitters were switched off.

When the 405-line service started in 1936 it was described as "The world's first regular public service of high-definition television programmes". The number of viewers had been dwindling since the introduction of the duplicate 625-line ultra-high frequency (uhf) colour service in 1969. In its hey-day, the 405-line network comprised one hundred and seven transmitters.

After the formal opening by the Postmaster General, Major G.C. Tryon on 2nd November 1936, the service grew in popularity when the BBC screened the first major outside broadcast in May 1937, the Coronation of King George VI. Over 23000 receivers were in use in September 1939 when the Alexandra Palace transmitter was closed for the war years. The service re-opened after the war in 1946, screening the Victory Parade on the 8th June.

Television spread throughout the UK with stations at Sutton Coldfield serving Birmingham and the Midlands opening in 1949, Holme Moss serving Yorkshire and Lancashire in 1951, and Kirk O'Shotts and Wenvoe serving parts of Scotland and Wales in 1952. The London transmitter moved to Crystal Palace in 1956 to provide a better signal to London and the Home Counties.

Software availability slammed . . .

Although one in every four homes in Britain has a computer, the Consumers' Association reports that the ready availability of software is deplorable. In a guide to software, the association says that most computer retailers, on average, stock only the twelve best-selling software packages. Over 3000 programs have been produced for the Spectrum, but even the largest stores have only about one hundred of these on the shelf.

. . .and hardware in decline

This year may well prove to be a watershed for many computer companies. Sales of home computers last December did not reach the expected figures and were even slightly below those for the corresponding period in 1983. Only winners were Sinclair, with the Spectrum outselling almost all other computers together. It is reported, however, that the QL is doing badly. Towards the end of last year, Sinclair were shipping 100 000 Spectrums a month, while total output of QLs for the year is claimed to be 40 000.

It is also reported that Acorn are doing badly, with the BBC micro taking a nosedive. The Acorn Electron is still number three in the UK but well behind Sinclair and Commodore.

A British company that did well in 1984 is Amstrad whose hi-fi style micro comes complete with tape drive and monitor.

Oric, however, found the ground too hot in the UK and has all but left these shores, hoping to do better in France where its Atmos was voted the best micro in 1983.

The big losers are undoubtedly the Japanese whose much heralded identikit MSX machines have so far failed to get off the ground. Toshiba, for instance, imported 40 000 MSX machines and estimated in January to have sold about 20 000. The problems with the MSX seem to be fourfold: they look obsolescent; they suffer from a serious shortage of software; there is a distinct lack of market awareness; they are too expensive (at an average price of £280 they are no bargain compared to the £180 Spectrum+ or the £190 Commodore 64).

Marconi enters cellular radio market

Marconi Mobile Radio, a division of Marconi Communication Systems Limited, has announced its entry into the Cellular Radiophone market.

The new Marconiphone Cellular products include a choice of two vehicle mounted sets, and a modern cordless personal radiophone that has battery charging facilities. This new equipment meets all the demands of modern Cellular Radiophones, including a wide range of standard telephone facilities, an electronic memory that stores the thirty most often called numbers, hand-free dialling, conferencing, and a call redirect facility. Other options are to follow.

To satisfy the growing cellular radiophone market, Marconi are further expanding their national radiophone sales and service centres, particularly in London, where their Wembley centre will be able to handle over one hundred car installations per week.

Optical mouse

Disk drive manufacturer Shugart Corporation has introduced an optical mouse, a palm-sized device used to position a cursor on a microcomputer screen.

The optical mouse offers several advantages over mechanical devices. Since the optical mouse has no moving parts, it is more reliable, does not require periodic maintenance, and is lighter and quieter than mechanical units. The Shugart product is also more reliable than most other optical mice since it has no internal mirrors to adjust.

The Shugart mouse can be moved up to twenty-five inches per second without affecting cursor positioning accuracy. It also features 200 pulse edges per inch to accommodate high resolution graphics. It is available with parallel, serial, or RS232C interfaces.

A sound conference

The International Telecommunication Union's (ITU) regional administrative radio conference to plan the use of the 87.5. . .108 MHz VHF sound broadcasting band, which ended last December, involved about 100 countries in Western and Eastern Europe (including the whole of the USSR) plus Iran and Afghanistan, and the whole of Africa. Is has established a broadcasting plan for the entire area: the Final Acts will come into force on 1 July 1987.

The UK delegation was led by officials from the DTI's Radio Regulatory Division, and included representatives from the Home Office Broadcasting Department, the BBC, the IBA, and the Civil Aviation Authority.

The UK's objectives for the conference were:

- to secure a further two national VHF networks, one to enable BBC Radio 1 and Radio 2 to have separate frequencies, and the other for the introduction of a new independent national radio service;
- the provision of additional frequencies for the development of BBC and independent local radio;
- the maintenance of the existing VHF networks and improvements to their coverage.

These objectives were accepted with only very minor modifications, and the plan thus establishes the regulatory framework within which present and future VHF sound broadcasting in the UK can be developed.

SERT twenty years old

The Society of Electronic & Radio Technicians, SERT, celebrated its twentieth anniversary last month. It was established in 1965 to provide professional services both for Technician Engineers and for Engineering Technicians. Today, the society has over 8500 members in the UK and many countries overseas, while its activities range from local and regional meetings for members to the organizing of major electronics related symposia that attracted participants from Europe and the USA. One of the prime objectives of the SERT has always been to gain recognition of the standards of its corporate members by industry and the general public. As a nominating body of the Engineering Council, it shares with the Council the desire to establish standards of competence for all engineering staff.

Exit for silicon?

The end may be in sight for silicon, the semiconductor material that made the computer boom possible and gave its name to California's 'Silicon Valley'. Use of gallium arsenide (GaAs) in semiconductors, a

NEWS VIEWS PEOPLE

faster, harder substance, will multiply nearly tenfold by 1992, according to a new study by Frost & Sullivan. *The Gallium Arsenide Semiconductor Market* (# 1352) notes that in many fields GaAs semiconductors are in an excellent position to challenge silicon ones, and the technology is headed in that direction. Integrated circuits will be the major market because of several material factors:

- in lower field intensities, the greater electron mobility of GaAs could translate into (processing) speeds ranging from three to ten times as fast as silicon at similar power;
- GaAs can be operated at much higher temperatures than silicon — an important reliability characteristic;
- GaAs has superior radiation resistance, important for hazardous and harsh radiating environments: this is of particular note for satellite applications.

The main applications for GaAs semiconductors lie in communications: satellite broadcasting systems, cellular radio, digital audio, and television.

World database

Comprehensive and up-to-date information on products, skills, knowledge, and facilities provided by the UK's universities, colleges, and research establishments will be available throughout the world from a computer database being set up in the Scottish Development Agency's newly-completed technology centre on the St Andrews University campus.

Financial backing for the project, which will be marketed by Catermill Publishing, has come from the SDA, Electra Investment Trust, and the Longman Group.

Among the subjects to be covered are the life and physical sciences, medicine, biotechnology, electronics, and engineering. The database is expected to be available to industrial users within a year, but work on gathering data has already started. (LPS)

MIQAL to the aid

Paisley College of Technology has been given Government approval to set up a unique education and training centre for Scotland's electronics industry.

The £0.5 million Microelectronics and Quality Assurance Laboratory (MIQAL — pronounced Michael) will be based in the college's Department of Electrical and Electronic Engineering, and will be funded jointly by the Scottish Education Department, the SDA, and by the electronics industry itself.

Several leading companies — Ferranti, IBM, Barr & Stroud, Burroughs Machines, Hughes Microelectronics, Hewlett Packard, and Digital Equipment Corporation — as well as the Engineering Industry Training Board, have already committed a total of £75 000 to the project, with other companies expected to follow in the near future.

MIQAL offers an extensive range of education and training courses specifically designed to meet the needs of Scotland's fastest growing industrial sector. With microelectronics scheduled to undergo still further expansion in Scotland by 1990, the Centre will play an increasingly important role, according to its creator, Professor Lionel Davis, Head of Paisley's Department of Electrical and Electronic Engineering.

Decision time...

The London-based International Maritime Satellite Organization (INMARSAT) expects to make a decision early this year on who will build its next generation of maritime communication satellites.

Two international consortia have bid to provide the organization with up to nine satellites. One is headed by British Aerospace in partnership with the Hughes Aircraft Company of the US and Satcom International of France. The other is headed by Britain's Marconi group and made up of the Ford Aerospace and Communications Corporation of the US and Aerospatiale of France.

INMARSAT's first generation satellite system is now linked with more than 3000 earth stations mounted on ocean-going vessels, off-shore oilrigs, seismic survey ships, fishing boats, ice breaker, cable laying ships, and shipping company offices. (LPS)

The roll-up, fold-up battery

Rechargeable batteries of the future, big enough to drive a car, and yet small enough for ordinary home use, are likely to be completely solid and capable of being rolled up like sticking tape or made in flat sheets and folded.

This is the prospect held out by a new project just launched by scientists at the UK Atomic Energy Authority's Harwell research laboratory. Their work to find the right materials and technology to enable solid batteries to be offered in any shape or size is being sponsored by battery users, manufacturers, and materials specialists.

According to a UKAEA spokesman, the project will provide the basic technology for the manufacture of all-solid batteries. These are likely to be made from lithium and vanadium oxide instead of the lead and nickel-iron of conventional batteries.

Harwell's applied electrochemistry centre has already shown that its new type of battery cells do work. Using foil-thin strips for the components, a complete cell need be only 0.22 mm thick, and this is likely to be reduced further still.

Harwell has been working on solid batteries for some time. With help from Denmark, the EEC, and several universities, is has been studying the possible use of lithium batteries to drive cars. (LPS)

People

Gordon Parker, BSc, C Eng, MIEE, Head of BBC's Engineering Designs Department, retired on 11 January and was succeeded by Ian Millar, MA, until then Head of Studio Group.

New show for electronics in retailing

The new electronic retailing and distribution exhibition, Retail '85, covering innovations in electronic retailing and all the equipment relevant to modern competitive trading, is to be held at the Kensington Exhibition Centre, London, from 16 to 18 April 1985.

The equipment on display is also expected to be of interest to other businesses where cash and stock control, display and security are important considerations. These include the catering and hotal industry, cash and carry outlets, the motor trade, and petrol filling stations. (LPS)

selektor

Grand Unification: for and against

During the past few years two important events in fundamental particle physics have provided evidence on the one hand for and on the other against grand unified theories, known as GUTs for short, which seek to explain all the fundamental particles of matter and all the forces of nature in the same mathematical terms. The first event is really a non-event: it is the failure of physicists so far to detect proton decay. The second is the production and identification of particles called W and Z bosons, findings which strengthen the case for GUTs perhaps more than it is weakened by the failure to find protons decaying.

Protons, the positively-charged particles in atomic nuclei, certainly have very long lives. They last for billions of years before they decay, losing mass as energy and changing into other particles. In fact it is still uncertain whether protons do decay. Scientists in India, Europe and America have set up experiments deep underground with sensitive detectors to search for proton decay. The reason for siting the experiments underground, in a disused gold-mine in India, in the Mont Blanc tunnel in Europe and in a salt mine in North America, is that it prevents the detectors being confused by the arrival of highly energetic particles in cosmic rays from outer space. No event generally accepted by physicists as being due to proton decay has yet been detected by any of the scientific teams.

The failure to detect proton decay is important to grand unification theory. There are several reasons for wishing to observe it, among them the fact that it probably happened a lot in the first fraction of a second after the 'big bang' in which the universe began. Observing proton decay would provide a replay of one of the more important events of that all-important earliest epoch.

Equally important is the evidence that proton decay would provide for symmetry and unity in nature. If protons decay, then the particles of which protons themselves are made up, namely quarks, have to be transformed into others called leptons, the generic name for particles such as electrons. Quarks and leptons are now believed to be the only two truly fundamental types of particles, and groupings of various types of quarks on the one hand and leptons on the other are beginning to look very similar. If proton decay shows that quarks can be transformed into leptons, then the unification of all forms of matter is in sight. For proton decay to mean that quarks and leptons are interchangeable, however, implies an average lifetime for protons before they decay of about 10^{31} years. The more the observed lifetime of the proton exceeds this span, the less likely it is that quarks and leptons are interchangeable and the further the unification of matter which depends upon it recedes.

So, the failure of physicists to agree that they have found decaying protons in any experiment so far, and the consequent implication that the lifetime of the proton is longer than had been thought (statistics show that they should have found several decaying by now if the lifetime was as predicted) does not encourage GUTs. But while the physicists involved have been taking one step back from GUTs, other groups may be said to have taken two steps forward with their identification of the W and Z bosons.

To understand why this is so important, you need first to understand how far unification of the forces of nature has proceeded. Matter is held together by four forces: gravitation, electromagnetism, and the strong and weak nuclear forces. The great physicist James Clerk Maxwell unified the hitherto separate electrical and magnetic forces into one in the 19th century. Just over ten years ago particle physicists Abdus Salam in the UK and Steven Weinburg and Sheldon Glashow in the USA constructed a theory which unified the electromagnetic and weak nuclear forces. To prove it meant that particles, the so-called W and Z bosons which the theory predicted must exist, had to be found.

The electromagnetic force between particles is carried by other particles, photons. If, as Salam, Weinberg and Glashow predicted, weak and electromagnetic forces are really just two manifestations of the same thing, the weak nuclear force should also be mediated by particles, the W and Z bosons.

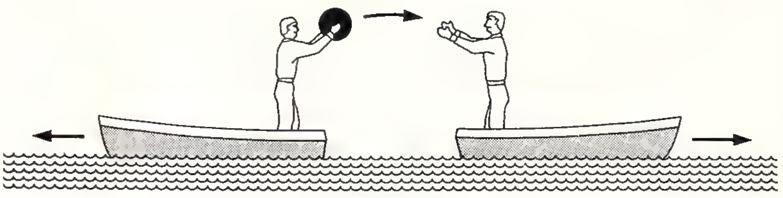
W bosons must be very heavy and so operate over very short distances. It requires very high energies to create W bosons that are not locked up inside atomic nuclei and that fly about freely enough and for long enough to be observed. Such energies were not available at the time when Salam, Weinberg and Glashow put forward their theory. But the energies needed to liberate detectable W and Z bosons have now been produced at the European Laboratory for Particle Physics, CERN, near Geneva.

The experiments involved colliding a beam of protons circulating inside the Super Proton Synchroton (SPS) with a beam of anti-protons circulating in the opposite direction. Each proton is made of three quarks and each anti-proton of three anti-quarks. When quark and anti-quark collide they annihilate each other and release enough energy to create particles as heavy as the W and Z bosons.

On 20th January 1983 CERN announced that, among some 10^9 collisions of particles observed in their proton-anti-proton colliding experiments, they had seen the characteristic signature of W bosons in just five. These observations were made by one of the two teams of scientists working with the SPS

The forces in nature

Type	Intensity of forces (decreasing order)	Binding particle (field quantum)	Occurs in:
Strong nuclear force	~ 1	Gluons (no mass)	Atomic nucleus
Electromagnetic force	$\sim \frac{1}{1000}$	Photon (no mass)	Atomic shell
Weak nuclear force	$\sim \frac{1}{100\,000}$	Bosons Z^0, W^+, W^- (heavy)	Radioactive beta disintegration
Gravitation	$\sim 10^{-38}$	Graviton?	Heavenly bodies

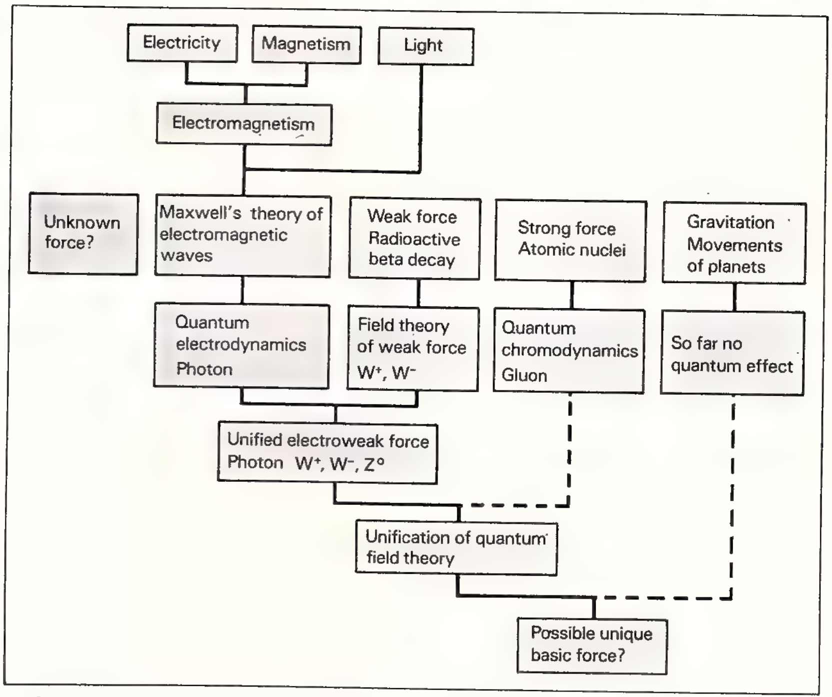


Exchange of particles is responsible for the forces proton-anti-proton collider, the team known as UA1. Soon after, four more such events were reported by the second team, UA2. Some 80 W bosons have now been seen and very recently five Z bosons have been identified.

The remarkable discovery rewarded six years of intense activity at CERN and on the part of the British participators in the CERN experiment, from the Rutherford-Appleton laboratory near Oxford, Queen Mary College in the University of London, and Birmingham University. Altogether, 120 international physicists, including 22 from the UK are involved in UA1. Their experiment uses a chamber that records the tracks of all the charged particles from the collisions of protons and anti-protons. Surrounding it are two arrays of counters to measure the energies of all the particles produced by the collision. One array measures the energies of leptons, the other the energies of strongly-interacting nuclear particles such as protons and neutrons.

This second array, called a Hadronic calorimeter, was built by the three UK scientific groups. It consists of seven thousand sheets of scintillators, detectors that scintillate when struck by the particles, with instrumentation to record and measure the energy of the impacts. The UK scientists also produced an electronic processor to measure the energy of impacts and to decide electronically whether or not they should be recorded. This vital part of the apparatus enables the experimenters to select, from the thousands of events produced every second by the colliding beams, just those that merit study.

The W boson is so heavy, about 80 times the mass of a proton, that it is created in a state of rest out of the energy of quark-anti-quark collision. It is unstable and decays almost immediately to lighter particles. One way in which it decays, which can be detected, is to form two particles — an electron and an anti-neutrino. Only the electron is discerned when this happens, because neutrinos cannot be detected by conventional means. So what should be discernable in this mode of decay is a high-energy electron track going off in one direction with, most unusually, nothing complementing it in the other direction. What has really happened is that while the high-energy electron has gone off in one direction carrying a momentum of 40 GeV (giga-electronvolts), half the energy of the W boson it came from, an anti-neutrino has gone off, undetectably, in exactly the opposite direction with a balancing momentum of 40 GeV. In the UA1 group's first experiments 800 000 events were recorded on magnetic tape; computer selection picked out 40 of them, and careful scanning of those produced just five that showed exactly the right characteristics, with high-energy electrons going off in one direction and a large amount of momentum clearly missing in the opposite direction.


Electricity
Magnetism
Light
Electromagnetism
Unknown force?
Maxwell's theory of electromagnetic waves
Weak force Radioactive beta decay
Strong force Atomic nuclei
Gravitation Movements of planets
Quantum electrodynamics Photon
Field theory of weak force W⁺, W⁻
Quantum chromodynamics Gluon
So far no quantum effect
Unified electroweak force Photon W⁺, W⁻, Z°
Unification of quantum field theory
Possible unique basic force?

Discovery of the W particle was followed in May by four events to do with Z particles. The Z particle is similar to the W but carries no charge and is slightly heavier. It is expected to be produced ten times less frequently by collisions between protons and anti-protons than is the W particle, which explains why the Z took longer to find, although its signature is equally distinctive.

Most physicists agree that the identification of the W boson cements the bond between the electromagnetic and weak nuclear forces. The next step in grand unification is to try to demonstrate that the strong nuclear force and the weak/electromagnetic forces are mediated by particles in the same way. A theory of the action of the strong force involving its mediation by particles, called gluons, already exists and it may be possible to confirm their existence experimentally. So far, however, physicists have made little progress towards assimilating the fourth force, gravitation, into a grand unified scheme of things.

Staniforth Webb (938 S)

IT training for UK and overseas students

British industry has already pledged more than £10 million to set up an Institute of Information Technology capable of training 6000 people each year in IT skills. The proposed institute will train students from home and abroad.

Sir Henry Chilver, principal of the Cranfield Institute of Technology, which runs courses for the government and the private sector in science, technology, and management studies, said recently that plans were now at an advanced stage. The institute would be set up in Milton Keynes where a wide range of IT services are already being developed for offices, homes, commerce, and industry.

The institute will be a wholly independent body but linked with nearby Cranfield in the field of production technology.

The first students will begin studies on short courses while on leave from their regular employment towards the end of this year.

By 1990 the aim is to have an annual output of 800 undergraduates, 500 postgraduate doctoral and master-degree students, and up to 5000 students on in-career short courses.

Among the British IT manufacturers and user companies now concerned in the institute's planning stage are BICC, Thorn-EMI, Racal Electronics, Plessey, STC, Ferranti, British Telecom, Cable and Wireless, Acorn Computers, and Longman Publishers. (LPS)

K.I.T.T. scanner

we let you in on the secret behind one of TV's special effects of the moment

Science fiction writers are hampered only by their own imaginations, which generally means that they are very little hampered indeed. Movie-makers, on the other hand, are often forced to take reality into consideration and do the best possible job with the tools that are available. Most of them, fortunately, succeed in making their films sufficiently 'unearthly' with special effects. Special effects also serve to enhance more ordinary films or TV shows, one of the most popular at the moment being a computer that thinks it is a car. Inspired by certain science fiction movies and our automotive friend we came up with a special effect unit of our own.

Movie makers and TV show producers feel justified in doing almost anything to draw a big audience or improve their ratings. One of the more popular of these 'special effects' shows at the moment has a fully-computerised car as its hero. This car (we will refrain from telling you that it is called K.I.T.T. as that would be advertising) has a series of lights running across its bonnet to simulate a 'scanner'. We all know, of course, that it is nothing of the sort but that does not detract from the effect.

Many special effects are very simple when the 'trick' is known. The 'KITT scanner', for instance, is simply a row of lights flashing in sequence one after another. As the photograph shows, this does not involve anything very complicated. Much of the circuit is repeated eight times. But before we get ahead of ourselves let us have a look at the actual circuit diagram.

The circuit

The operation of the circuit is easy to follow. When the power is applied the switch-on reset circuit, consisting of C4 and R19, takes pin 1 (Preset Enable) of counter IC3 high for a short time. The data presented to the parallel inputs, I1...I4, is loaded into the counter. All four of these inputs are grounded so IC3 is reset to zero. This has the effect that the circuit always starts from the same condition, except for the state of flip-flop N2/N3.

As long as the circuit is powered the oscillator based on N4 provides a clock signal for the 4029, with the frequency being preset by means of P1. The count in IC3 is incremented by each clock pulse and is continually output via QA, QB and QC. Each of these outputs is connected to a corresponding input in IC2. This binary information is decoded by the 4028 so one of its outputs is continually high. The 4029 always starts from a count of zero so this means that the first output of IC2 to be high will be pin 3 ('0'). Each successive clock pulse from N4 then causes the next of the 4028's outputs to go high, and the previous one to return low, of course.

When output '7' of IC2 goes high this signal is fed via N1 to flip-flop N2/N3 causing it to toggle. As a result pin 10 of IC3 is taken low so the 4029 starts to count down. When it reaches zero the $\overline{CO}$ output causes N2/N3 to flip again so IC3 starts counting up.

Each of IC2's outputs ('0'...'7') is connected to the exact same sort of circuit. When an output goes high the appropriate switching transistor, T9...T16, causes the corresponding driver transistor, T1...T8, to conduct so one of the lamps lights. The result is that each of La1...La8 lights, one after the other, first in rising sequence, then falling, then rising again,

1

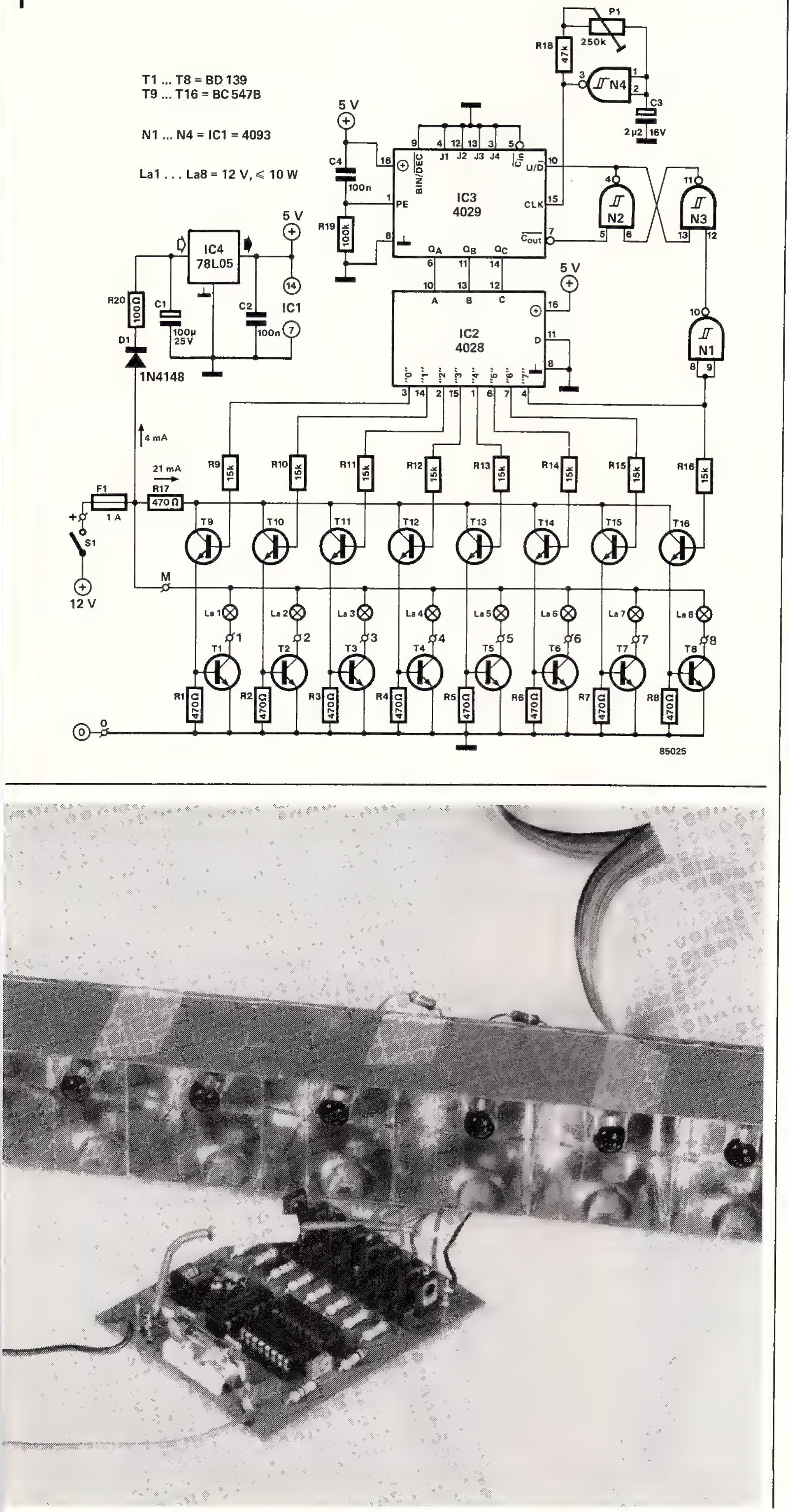


Figure 1. The circuit diagram and the photograph attest to the simplicity of the circuit. The electronics itself uses very little power, most of it being consumed by the eight lamps. The transistors will be overloaded if the lamps used have a higher power rating than the one stated in the drawing.

Parts list

Resistors:
R1...R8,R17 = 470 Ω
R9...R16 = 15 k
R18 = 47 k
R19 = 100 k
R20 = 100 Ω
P1 = 250 k preset

Capacitors:
C1 = 100 µ/25 V
C2,C4 = 100 n
C3 = 2.2 µ/16 V

Semiconductors:
D1 = 1N4148
T1...T8 = BD 139
T9...T16 = BC 547B
IC1 = 4093
IC2 = 4028
IC3 = 4029
IC4 = 78L05

Miscellaneous:
F1 = fuse, 1 A slow blow, with PCB-mounting fuse holder
La1...La8 = light bulb, 12 V/10 W max.
S1 = single-pole single throw switch

2

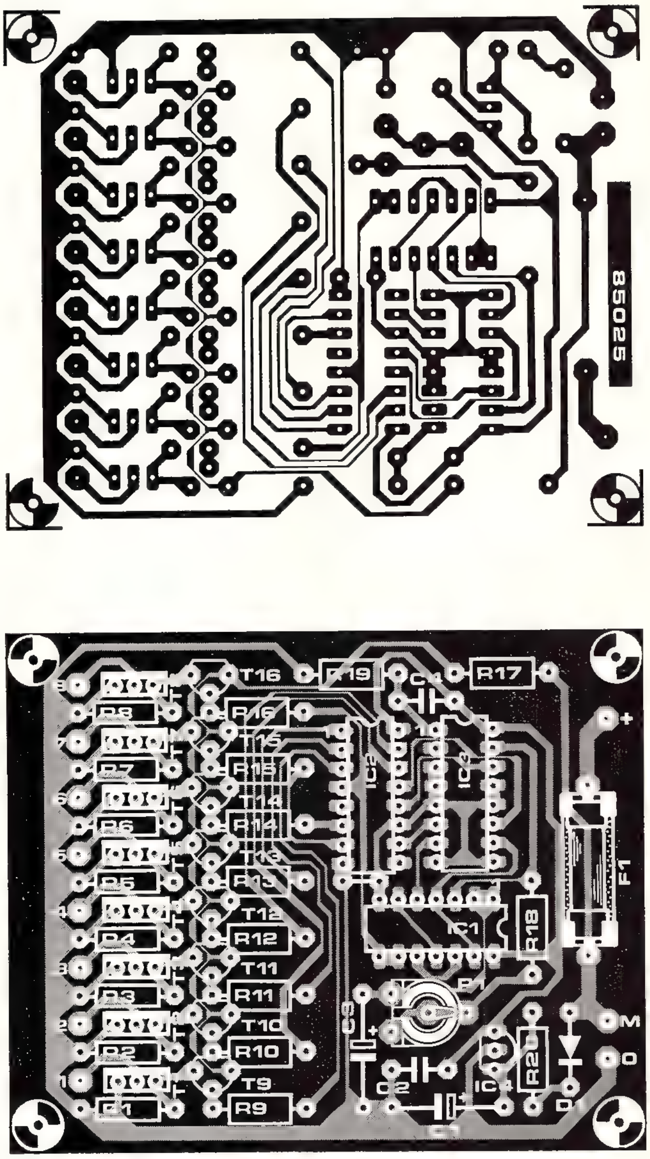


Figure 2. The scanner can be assembled on this printed circuit board (EPS No. 85025). Do not forget to insert the short wire link between IC1 and IC2.

and so on. The speed at which this occurs is determined by the position of P1.

The circuit requires a power source of 12 V d.c., such as a car battery, and its current consumption will be about 25 mA. The regulated 5 V needed for IC1...IC3 is provided by IC4. Incidentally, the switching transistors (T9...T16) need only a single common collector resistor as only one of them conducts at any one time.

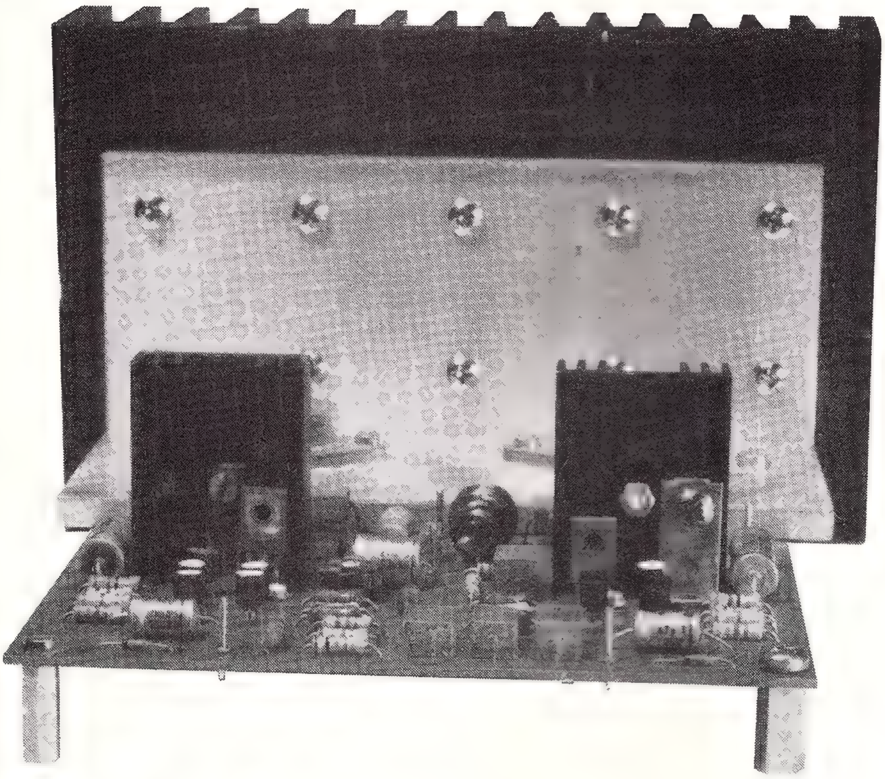
Construction and calibration

Assembling the circuit for the KITT scanner is simply a matter of soldering all the components onto the printed circuit board whose design is shown in figure 2. The mechanical section is no more difficult. The photograph shows how our prototype was put together. Each lamp is mounted in its own section in the reflector. The reflector is made of a number of pieces of tin soldered together. The wall between two lamps is not vertical; it consists of two pieces of tin soldered together in a 'V' shape with the free ends soldered to the floor of the reflector. Do not make these walls finish flush with the top of the reflector as we have done. The lamps will seem to run into each other better if the walls only extend about 2/3 to 3/4 of this height. A sheet of perspex was fitted in front of the reflector and this was covered with red tape.

The only variable component in the scanner is preset P1. This is 'calibrated' by adjusting it until the lamps flash at a speed that you find pleasing.

A final point...

...about using the circuit. As any policeman will tell you, not just anybody is legally permitted to fit flashing lights to their car, even if they are not blue. That means that the 'scanner' as shown on the TV show is illegal in most parts of the world. Elektor readers are imaginative, however, and we are sure you can come up with an even more innovative use for this KITT scanner.



This photograph of two AXLs forming a stereo amplifier shows how the printed circuit boards, the MOSFETs, the aluminium bracket, and the heat sink are connected together.

AXL amplifier

class A, B or AB

The AXL amplifier described here is intended for operation in class A, AB, or B. Its design specification stipulated that it should be reasonably compact, reliable, robust, and relatively inexpensive to build. It is suitable for use as a power amplifier for electrostatic headphones, in an active loudspeaker system, or in a small hi-fi installation.

The classification of an amplifier depends on the portion of the input current cycle during which output current flows. In class A amplifiers, output current flows over the whole of the input current cycle. These amplifiers have low distortion and low efficiency. In class B amplifiers the output current is cut off at zero input signal, so that a half-wave rectified output is produced. Such amplifiers are very efficient but suffer from cross-over distortion. In class AB amplifiers the output current flows for more than half but less than the whole of the input cycle. At low input-signal levels class AB amplifiers tend to operate in class A, and at high input-signal levels as class B amplifiers.
Power amplifiers commonly work in push-pull, that is, they use two matched devices in such a way that they operate with a 180° phase difference. The output circuits combine the separate outputs in phase. When complementary transistors are used in the two halves, no phase shift is required in the inputs. If both halves of the stage are active simultaneously, they

Technical data

Input sensitivity	790 mV_{rms} for 25 W into 8 Ω 700 mV_{rms} for 40 W into 4 Ω	
Input impedance	5 kΩ	
Power gain	25 dB	
Output power	15 W into 8 Ω 7 W into 4 Ω	class A — full drive quiescent current: 1 A
	2 W into 8 Ω 1 W into 4 Ω	class A — reduced drive quiescent current: 350 mA
	25 W into 8 Ω 40 W into 4 Ω	class AB — full drive
	50 W into 8 Ω 70 W into 4 Ω	class B quiescent current: 100 mA
Dissipation (no signal condition)	65 W	— class A with quiescent current of 1 A and supply voltage of ± 32 V
	23 W	— class A with quiescent current of 350 mA and supply voltage of ± 32 V
	9 W	— class B with quiescent current of 100 mA and supply voltage of 2 × 45...50 V
Frequency response	13 Hz...65 kHz at −3 dB class A 20 Hz...20 kHz at −3 dB class B	600 Ω source impedance
Harmonic distortion (primarily 2nd harmonic)	$\leqslant$ 0.02 per cent in frequency range 20 Hz...20 kHz	
Damping factor	100 (at 1 W output at 100 Hz)	

provide equal contributions to the output current; this is the case in class A operation. In class B operation only one half of the stage is active at any one time, and this depends on the polarity of the output current.

A predetermined mode of operation, A, B, or AB, is effected by suitably adjusting the quiescent current (that is, the current under no signal conditions) through the output stage. The quiescent current flows through both halves of the output stage. Each change in the current with respect to the quiescent current in each half of the stage contributes to the output current. In class A operation, the quiescent current is so high, and the output current so low, that both halves of the output stage are on all the time. In class B operation, the quiescent current is, in theory at least, zero. In class AB operation, the quiescent current is set to a level which is appreciably higher than in class B, but much lower than in class A.

Because of the heavy demands on the power supply and cooling, a class A amplifier is considerably dearer per watt output power than a class B amplifier. But, since the reproduction in class A is better than in class B, it seems logical to opt for a compromise: that is, class AB! This becomes even more attractive when you realize that during the reproduction of both music and speech full output is required during very short periods only. With a well-chosen quiescent current, the amplifier therefore sometimes works in class A (low inputs) and sometimes in class AB (high inputs). The consequent increase in distortion as compared with that in class A operation is measurable, but not audible.

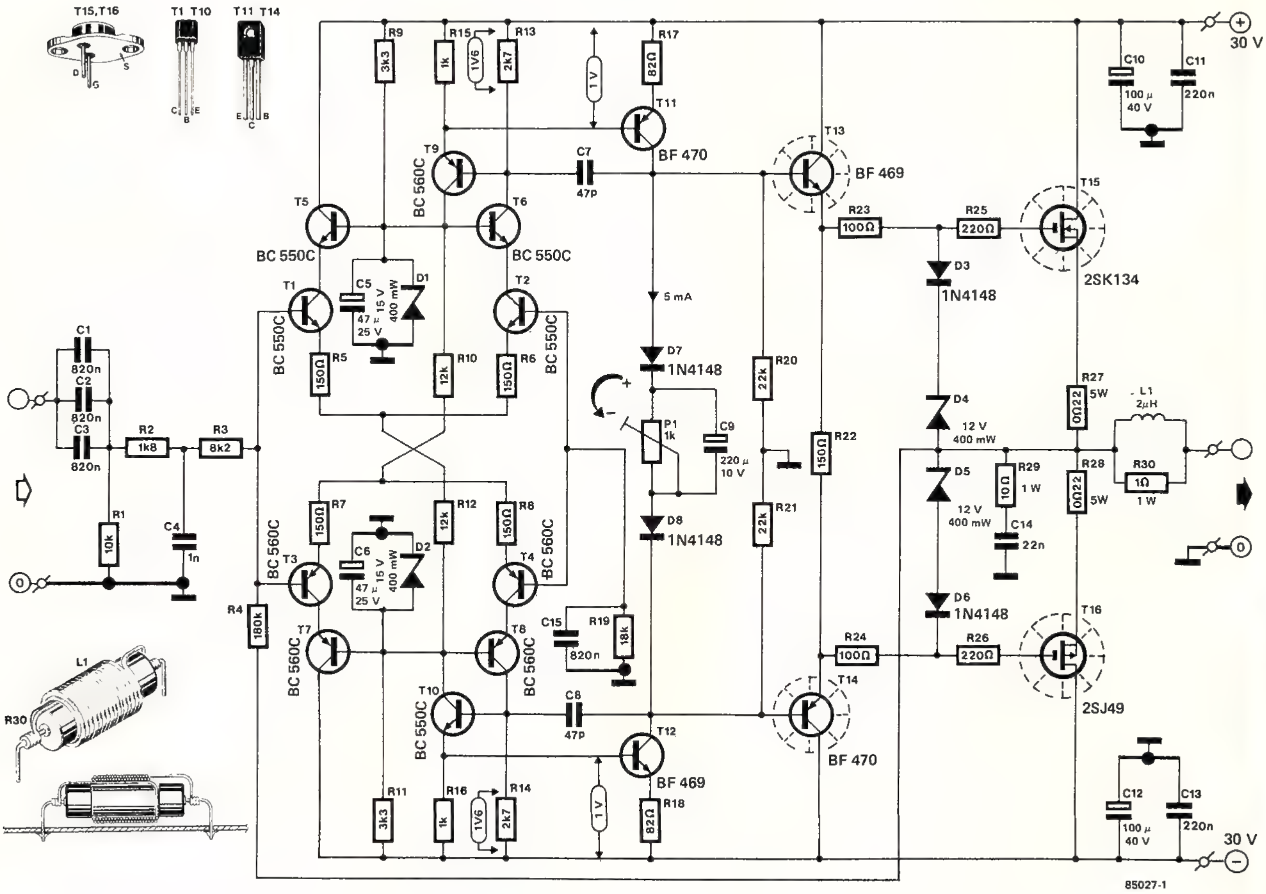
As to the question of rated power output, both the Crescendo (*Elektor* December 1982) and the Mini Crescendo (*Elektor* — May 1984) appear to meet a need, at least according to many readers' letters. But bearing in mind the design specification mentioned before, we modelled the AXL amplifier on the Mini Crescendo, resulting in a symmetrical circuit with two complementary MOSFETs in the output stage. Both as regards costs and dimensions, the case, the power supply, and the heat sinks are comparable to those in the Mini Crescendo.

Circuit

As most amplifiers, the AXL may be split into an input stage, voltage amplifiers, and an output stage. As shown in figure 1, the input stage consists of a dual symmetrical differential amplifier. The two transistors normally constituting a differential amplifier are formed by cascodes T1-T5, T2-T6, and T3-T7, T4-T8 respectively. A cascode is a super-transistor in which there is only

Figure 1. The circuit diagram of the AXL amplifier.

1



negligible feedback from collector to base. Furthermore, the collector of such a transistor is an almost ideal current source.

The output voltages of the differential amplifiers are present across resistors R13 and R14 from where they are applied to driver stages T11 and T12 via emitter followers T9 and T10. Note that the collectors of the emitter followers are conveniently connected to zener diodes D1 and D2 which are required to ensure proper balance between the two sections of the dual input circuit.

In contrast to the two Crescendos, drivers T11 and T12 are not connected in a cascode circuit, because the output stage here is voltage-controlled via complementary emitter follower T13+T14. This dual stage can draw a sufficiently high current via R22. This arrangement obviates the need of using the input capacitance of the MOSFETs for frequency compensation. This compensation is now obtained via Miller capacitors C7 and C8, which in essence are connected between base and collector of T11 and T12 respectively. There is, therefore, a deliberate feedback from output to input of the drivers, and the aim of a cascode circuit is precisely to prevent such feedback. Current amplification in this arrangement is low, and this is the reason that emitter followers T9 and T10 have been added.

The collectors of the drivers are interconnected via network P1-C9-D7-D8, which serves to adjust the quiescent current to the required level. The diodes provide temperature compensation for the current set by P1; they derive their temperature essentially from the heat sinks of T13 and T14. The stability with temperature of the quiescent current is not of paramount importance in view of the excellent thermo-electronic properties of the MOSFETs.

The parallel combination of R20 and R21 forms the load of the driver stages. The values of these resistors have been chosen such that on the one hand the voltage amplification of the drivers is reasonably high, and on the other that the contribution of these resistors (via the current amplification mechanism of T13+T14) to the gate control impedances of T15 and T16 is negligible (that is, with respect to R23+R25 and R24+R26 respectively).

As already mentioned, the output stages of the AXL amplifier are voltage controlled, because that gives an even better linearity than current drive. It also keeps the output impedance, without feedback, lower. The improved linearity and lower output impedance result in very good overall performance with a low feedback factor. And that is desirable, because feedback is and remains a necessary evil.

Diodes D3...D6 provide simple, but efficient current limiting of the MOSFETs. Network R29/C14 improves the stability under no-load conditions. Resistors R27 and R28 act as stabilizers of the direct current setting of the output stages. Network

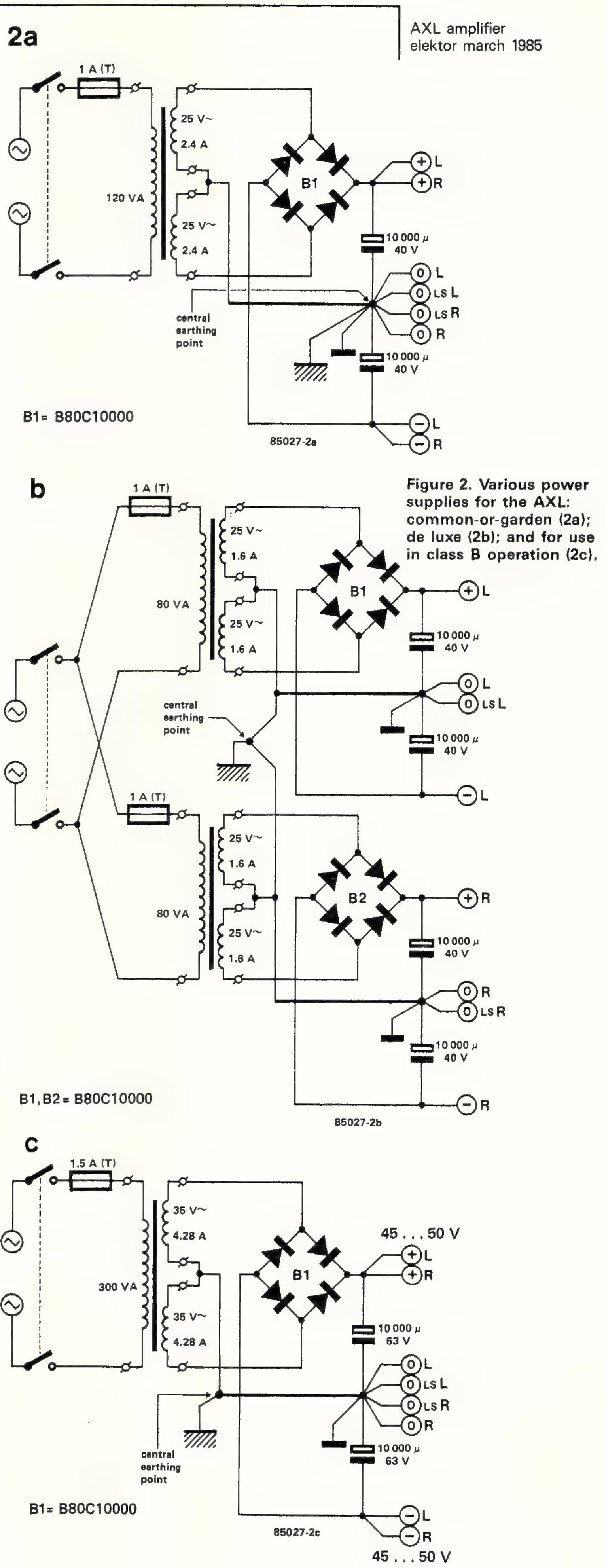


Figure 2. Various power supplies for the AXL: common-or-garden (2a); de luxe (2b); and for use in class B operation (2c).

3

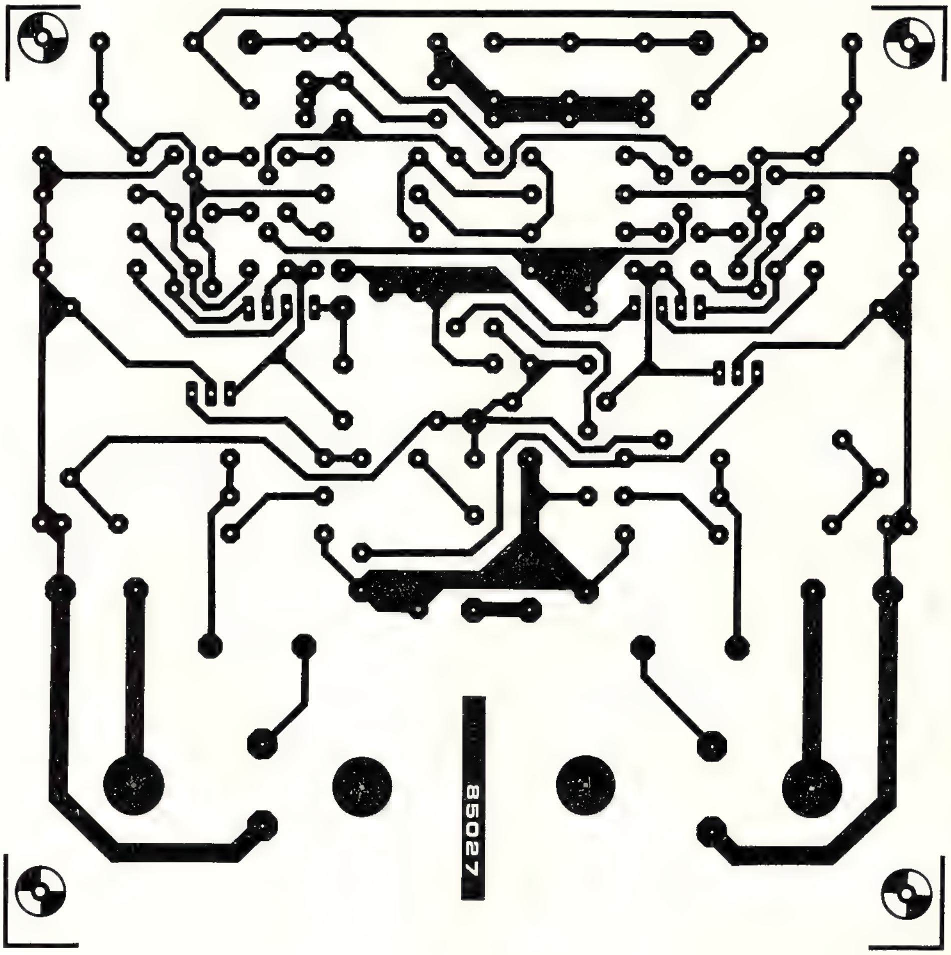


Figure 3. The printed circuit board of the AXL amplifier.

L1/R30 reduces to some extent the capacitive load at the negative-feedback take-off point. The feedback is applied to the input stages via R4. Capacitors C10. . .C13 provide decoupling of the supply lines.

The parallel combination C1-C2-C3, in conjunction with R1, provides a filter for d.c. and very low frequency signals. Filter R2/C4 prevents signals above about 60 kHz from reaching the input stages.

Construction

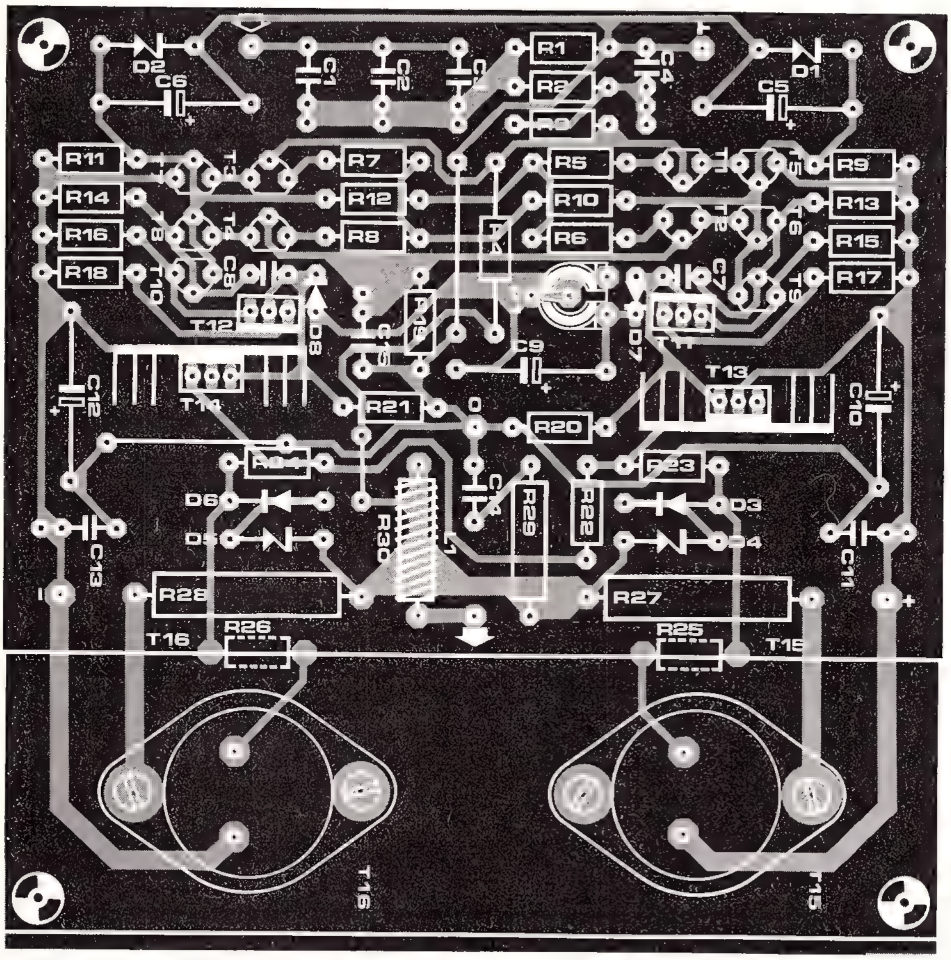
The AXL amplifier is constructed along similar lines as the two Crescendos, and it may therefore be useful to reread the two relevant articles. Note that the output transistors are mounted on the printed circuit board: thermal coupling with the heat sink is effected via a right-angled aluminium bracket as shown in the photograph on page 3-27. This arrangement obviates any critical wiring and results in a very compact construction.

As regards the power supply, figure 2 gives you a choice of three. Figure 2a shows one that is common to the left-hand and right-hand channel; figure 2b gives a design for separate supply to the two channels; and figure 2c is intended for use when the AXL amplifier is operated in class B.

The circuit of figure 2a is a single-transformer design. The large-value smoothing capacitors are necessary to keep the ripple voltage on the supply lines low; with smaller capacitances this voltage might easily become unacceptably large in view of the high quiescent current. The ripple voltage does not so much affect the audio signals as reduce the dynamic range.

Note that there are two earth returns per channel: one to the pcb, and one to the loudspeaker. The central earthing point should be the only connection to the amplifier case. This means that the phono (or jack) sockets must be mounted insulated from the case. The connections between these sockets and the pcb should be made in screened cable with the screen connected as appropriate at both ends of the short cable.

The design in figure 2b provides separate supplies for the left-hand and right-hand channels, which are normally only found in very expensive amplifiers. The arrangement ensures that there is guaranteed no interaction between the two channels via the supply lines. The great advantage of using this power supply is that a stereo amplifier can be built from two absolutely symmetrical mono amplifiers which only have the mains switch in common!



If it is required to operate the AXL permanently in class B, higher supply voltages are needed. A suitable power supply is shown in figure 2c. Note that the rating of capacitors C10 and C12 in the amplifier should also be increased to 64 V.

Construction of the amplifier on the printed circuit board is straightforward; note, however, that diodes D7 and D8 should be mounted vertically.

The mounting of the MOSFETs, the aluminium bracket, the heat sink, and all other practical constructional details have been described in the previous crescendo articles *(Elektor* — December 1982 and May 1984) and is further illustrated in the photograph on page 3-27.

Before the amplifier can be taken into use, it is necessary to check and, if necessary, to correct the off-set direct voltage at the amplifier output, and to set the quiescent current.

Ideally, the direct voltage at the output should be zero, but in practice a value of not more than ± 50 mV is perfectly acceptable. First, measure the direct voltage under no-load and no-drive conditions. If it is negative, T2/T6 and T3/T7 should be made to conduct harder, and T1/T5 and T4/T8 less so. This may be done by reducing R6 and R7 by a certain amount, and increasing R5 and R8 by the same amount. The total values of R5+R6 and R7+R8 therefore remain unchanged. For instance,

R6 = R7 = 120 Ω; R5 = R8 = 180 Ω.

If the direct voltage has risen to less than —50 mV, no further action is required; if not, the resistance values should be changed further, e.g.,

R6 = R7 = 100 Ω; R5 = R8 = 220 Ω.

If the direct output voltage is too high and positive, R6 and R7 should be increased, and R5 and R8 reduced, in a similar way to that described for negative values.

The quiescent current is measured by connecting a d.c. milliammeter in the positive or negative supply line, or by a d.c. millivoltmeter across R27 or R28 (about 25 mV per 100 mA). The quiescent current may be set with P1 between 100 mA and 1 A. The lower value pertains to class B operation, the higher to class A. We have found that a value of 350 mA gives the best compromise between performance and dissipation, but the final choice is, of course, yours!

Parts list (each channel)

Resistors:
R1 = 10 k
R2 = 1k8
R3 = 8k2
R4 = 180 k
R5,R6,R7,R8,R22 = 150 Ω
R9,R11 = 3k3
R10,R12 = 12 k
R13,R14 = 2k7
R15,R16 = 1 k
R17,R18 = 82 Ω
R19 = 18 k
R20,R21 = 22 k
R23,R24 = 100 Ω
R25,R26 = 220 Ω (mount on trackside of pcb)
R27,R28 = 0Ω22 5 W
R29 = 10 Ω/1 W carbon
R30 = 1 Ω/1 W carbon
P1 = 1 k preset (turn fully anti-clockwise before mounting)

Capacitors:
C1,C2,C3,C15 = 820 n (preferably MKM = metallized plastic polycarbonate)
C4 = 1 n polystyrene
C5,C6 = 47 µ/25 V
C7,C8 = 47 p polystyrene
C9 = 220 µ/10 V
C10,C12 = 100 µ (rated voltage> single supply voltage)
C11,C13 = 220 n
C14 = 22 n

Semiconductors:
T1,T2,T5,T6,T10 = BC 550C
T3,T4,T7,T8,T9 = BC 560C
T11,T14 = BF 470
T12,T13 = BF 469
T15 = 2SK134 (Hitachi-MOSFET)
T16 = 2SJ49 (Hitachi-MOSFET)
D1,D2 = zener 15 V/400 mW
D3,D6,D7,D8 = 1N4148 (mount D7 and D8 vertically)
D4,D5 = zener 12 V/400 mW

Miscellaneous:
L1 = about 2 µH: 20 turns in 2 layers of 1 mm dia. enamelled copper wire (SWG19) on R30; see detail in figure 1
heat sink for T15 + T16; minimum height 100 mm; e.g. SK85; 0.6°C/W
aluminium bracket, right-angled, minimum dimensions: 125 mm long, 6 mm thick, each side 60 mm wide
two heat sinks for T13 and T14, 8.5°C/W, e.g. SK09
mounting and insulating hardware and silicon grease substitute for the transistors to be cooled

Determining the pH value of an aqueous solution is one of the more important measurements in inorganic chemistry. Any connection with electronics seems remote, and yet chemists have made use of electronics in pH measurements for years. They do this with a special sensor which enables the degree of acidity or alkalinity to be displayed analogously or digitally. Until recently these sensors were prohibitively expensive for hobbyists, but as prices have been coming down, we decided to design a pH meter which will be particularly appreciated by aquarium owners.

pH meter

acidity/alkalinity measurement by LCD

As most electronic hobbyists are no chemists, we will keep 'chemistry' to an absolute minimum.

Each aqueous solution has a certain measure of acidity or alkalinity, which is dependent on the concentration of hydrogen-ions in it. The higher the concentration, the higher the acidity, and the lower the pH. When the concentration is low (very few hydrogen-ions), the pH is high and the solution is alkaline. A pH below 7 indicates acidity and a pH in excess of 7 indicates alkalinity.

The pH is defined as the logarithm of the reciprocal of the hydrogen-ion concentration, (H^+), i.e. pH = $\log_{10} 1/(H^+)$

Table 1 gives the pH scale with corresponding numbers of grams of hydrogen-ions per litre of solution, the relative strength of the solution, and typical examples.

A neutral value does not correspond to a concentration of zero ions, but to one which lies at the division between acidity and alkalinity: that is a pH of 7. The concentration is also dependent to some extent on the temperature of the solution. Depending on the nature of the solution, the pH/temperature relation is either direct or inverse. Measurement of the pH is normally related to a temperature of 25°C.

Table 1.

pH		hydrogen-ions in g/l	relative strength	typical example
0	acid	1.0	10 000 000	5% hydrochloric acid sulphuric acid
1	↑	0.1	1 000 000	gastric juice
2		0.01	100 000	lemon juice, vinegar
3		0.001	10 000	fruit juice, wine
4		0.0001	1 000	beer
5		0.000 01	100	black coffee
6		0.000 001	10	mineral water, rain water
7	neutral	0.000 000 1	0	purified water, fresh milk
8		0.000 000 01	10	solution of washing soda
9		0.000 000 001	100	borax solution
10		0.000 000 000 1	1 000	soapy water
11	↓	0.000 000 000 01	10 000	film developer
12	alkaline	0.000 000 000 001	100 000	ammonia solution
13		0.000 000 000 000 1	1 000 000	lime water
14		0.000 000 000 000 01	10 000 000	10% caustic soda solution

There are two methods for determining the number of H^+ ions in an aqueous solution: colorimetry and electrometry.

In the first, an acid-base indicator is used, which has a different colour in acid or base solutions. The colour change is due to a marked difference in colour between the undissociated and ionic forms. Such indicators are accurate only to about 30 per cent.

The electrometric method is based on comparing the voltage measured by a sensor and a reference potential. A detailed description of this sensor is given later in this article.

The output potential of the sensor changes by about 59 mV per pH unit; this is a reasonable value which may be measured direct with a d.c. voltmeter.

Because of the temperature-dependent behaviour of the pH sensor, a temperature sensor was thought to be no luxury. Our pH meter therefore includes a pH sensor and a temperature sensor, with the temperature correction for the pH sensor being made automatically. Moreover, the temperature can be displayed independently.

Electronic part

The circuit of the pH meter uses a special voltmeter IC and is therefore quite straightforward as figure 1 shows. This chip, IC1, contains a dual-slope analogue/digital converter and a complete LCD drive stage.

Capacitor C2 is a memory for the auto-zero function in the IC. Capacitor C3 is an integrator which is charged via R1. Reference capacitor C1 is also part of the dual-slope integrator. The battery is connected to the IC (pins 1 and 26) via switching transistor T1. This transistor is controlled by a micro-switch in the stereo socket for the temperature sensor; it conducts only if the plug of that sensor has been inserted into the socket. This makes an on/off switch superfluous.

The POL(arity) output, pin 20, switches on the minus sign on the display via gate N3 when the input signal is negative. The TEST output, pin 32, arranges a low-battery signal on the display if the battery voltage drops below 7.8 V.

The LCD display is controlled via outputs A1. . .G1, A2. . .G2, and A3. . .G3. The decimal point is set according to the chosen function by N1 and N2.

The reference voltage is connected to REF HI and REF LO (pins 36 and 35 respectively), while the potential difference from the pH sensor is applied to IN LO and IN HI (pins 30 and 31 respectively).

When the reference voltage is suited to the quantity to be measured (temperature or pH) and the starting voltage of the measuring range (IN LO) is preset appropriately, the display will give a direct reading of the temperature or the pH value.

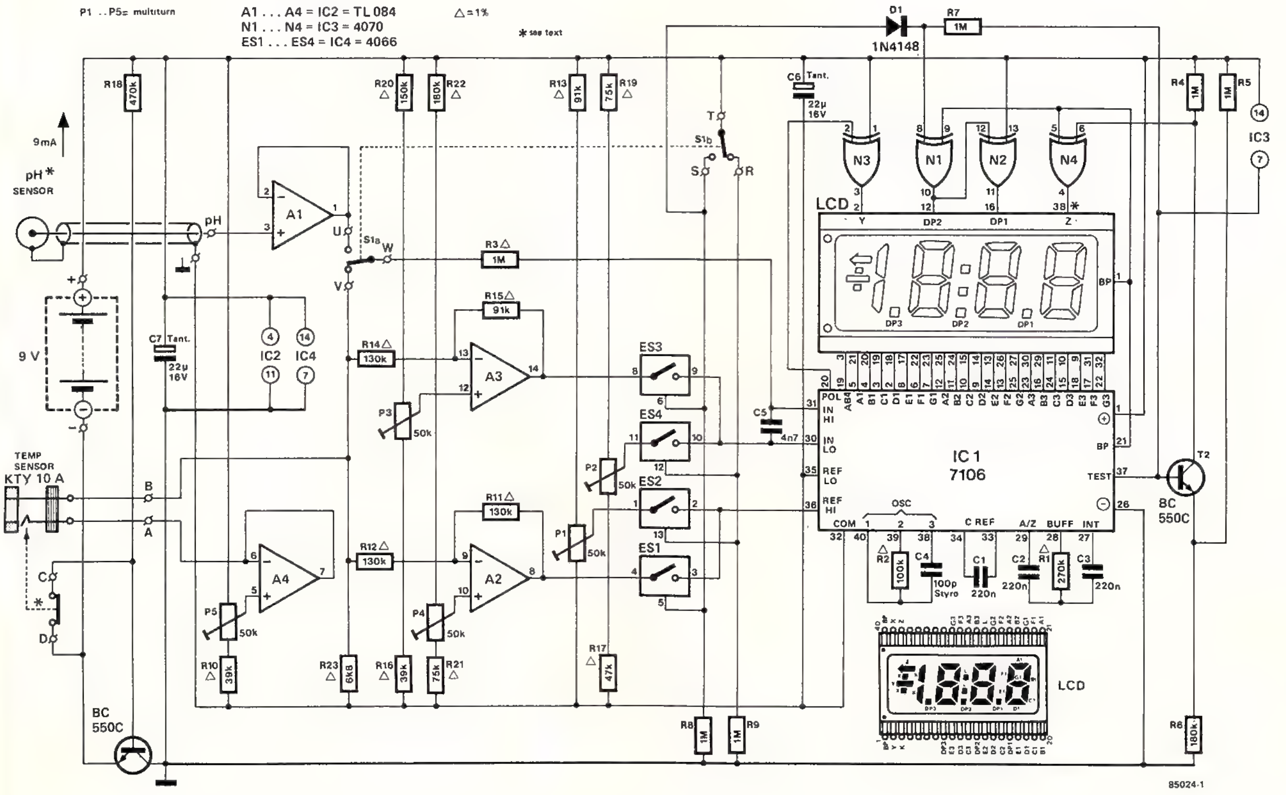
Input REF LO is connected to COM (pin 32), which is not the earth connection of the IC, but provides a stabilized potential which is about 3 V below the 9 V supply voltage. The reference voltage for temperature measurements is set simply by R13/P1; that for pH determination is provided by voltage divider R22/P4/R21 and opamp A2. Switching between the two reference voltages is carried out by electronic switches ES1. . .ES4. The starting voltage for measuring temperature and pH is preset by R19/P2/R17 and R20/P3/R16/A3 respectively.

With switch S1 in position R/V, the temperature sensor is connected between A (1.69 V reference voltage provided by opamp A4) and B. In this way, the sensor forms a temperature-dependent voltage divider with R23. At 0°C the resistance of the sensor is about 1650 Ω and the potential at B (with respect to earth) is then around 1.3 V. The level at IN LO is set to the same value by P2, so that the display reads 00.0 at 0°C. At higher temperatures, the resistance of the sensor decreases, the voltage at B rises, and the display will then read a positive value. Similarly, at temperatures below 0°C, the display will indicate a negative value. The reference voltage is preset with P1.

Opamp A1 at the pH input provides the required high input impedance of 10^{12} Ω. It would be possible to connect the pH input direct to the relevant inputs of IC1 (also 10^{12} Ω) but switch S1 would then have to be of very high quality to provide such a high isolation resistance between its contacts. As there was a spare opamp available in IC2 anyway, we opted for using that and a cheap switch. The output voltage of the pH sensor drifts about 200 μV/°C. This means that the reference voltage must drift 200 μV/°C in the opposite direction to compensate for the

Figure 1. The circuit diagram of the pH meter is based on a special IC which processes the voltages provided by a pH sensor and a temperature sensor: the results are shown on a 3½ digit LCD display.

1



sensor drift. This correction is provided automatically by opamp A2. The inverting input of this opamp is therefore connected to the temperature sensor via a resistor. The ratio R11:R12 determines the drift per °C.
A separate setting by P3 arranges for a suitable level at the IN LO input. At pH = 7, the pH sensor provides a voltage of around 0 V, but it is preferable and much more convenient for the display to read 7.00. This is achieved by voltage divider R20/P3/R16 and A3, which combine to provide a voltage of 413 mV (7 × 59 mV) at the IN LO input. This setting is also temperature dependent: compensation is provided automatically by R14/R15.

Construction

The printed circuit shown in figure 2 contains relatively few components, which makes construction a fairly simple matter. However, the choice of those components is pretty important. Many resistors (those marked with an asterisk in the parts list and a triangle in the circuit diagram) MUST BE metal film types. This is not so much because of high tolerance, but rather to

The pH sensor

In pH measurements use is made of the potential difference that exists between a metal electrode and the electrolyte into which it is immersed. Such a potential difference also exists between two different electrolytes. Electrolytes may be acids, bases, or salts.
In electrometrical pH measurements a galvanic chain is used which consists of two electrodes that are electrically connected by one or more electrolytes. Externally, the two electrodes are interconnected by a measuring device of very high internal resistance. As this device draws virtually no current, the chemical constitution of the electrolyte is not affected.
Several galvanic voltages are produced in the chain which cannot be measured independently. In the sensor used here, there are therefore a reference electrode and a measuring electrode: figure 4 shows a sketch of the construction.
As the name implies, the reference electrode provides a fixed galvanic voltage between it and the electrolyte to be measured. It consists of a rod of silver compound which is surrounded by a buffer solution, potassium chloride, KCl. The potassium chloride is connected with the electrolyte via a diaphragm which ensures minimal liquid transfer and very low electrical resistance. In the sensor used here, the diaphragm is made of a porous ceramic.
The measuring electrode consists of a silver rod which is bonded to a glass membrane and surrounded by a potassium chloride solution. A potential difference will arise across the membrane which is dependent upon the difference in acidity/alkalinity between the buffer solution inside the sensor and the electrolyte into which the sensor is immersed. The potential difference is probably caused by an exchange of sodium and hydrogen ions between the glass and the solutions.
The potential difference between the two electrodes is directly proportional to the difference in pH of the buffer solution and the electrolyte. All other galvanic voltages cancel one another. Because of the high transfer resistance of the measuring electrode, and to prevent chemical changes in the solutions, the measuring device interconnecting the two electrodes externally must have a very high impedance input — of the order of 10^{12} Ω.

4

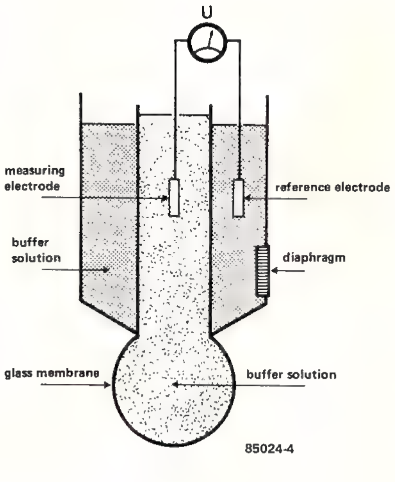


Figure 4. Construction of the pH sensor used for this article.

Using the sensor

It should be evident that because of the glass membrane the sensor should be used with care.
The sensor used contains a maintenance-free buffer solution. In other words, the solution around the two electrodes cannot be replenished. To prevent drying out of the solution, the sensor should therefore always be kept in a potassium chloride solution when it is not in use.
Some golden rules for using the sensor are:

- Never leave the sensor unguarded. A protective cap is supplied which should always be placed over the membrane side. This cap is filled with potassium chloride and may need replenishing once in a while with a KCl solution of 3 mol/litre (this is available as a standard solution).
- Never touch the glass membrane — not even with a cloth, because this will almost certainly destroy the electrode.
- Before every measurement rinse the sensor thoroughly in distilled water.

ensure good stability. All presets MUST BE 10-turn cermet types. IC1 MUST BE a type 7106 and not a type 7106R, because that has all connecting pins reversed w.r.t. the 7106.

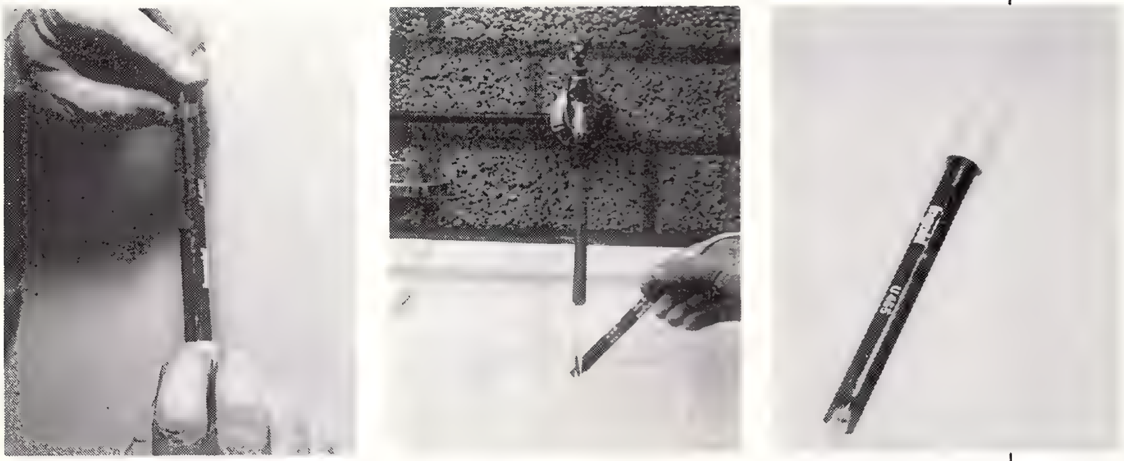
After all components have been mounted on the component side, the display should be fitted at the track side. Use a 40-way IC socket which has been cut lengthways as holder. Note that some types of display do not have an arrow for battery indication, but LOW BAT or some other sign. In such cases it may be that the battery indication is terminated in another than pin 38.

Then, place the printed circuit in the box, but do not yet secure it. Just see where the packing density at the edge of the board is least and on that basis determine the location for switch S1 and the BNC socket at the underside of the box. Screen the BNC socket with a piece of tin soldered in position.

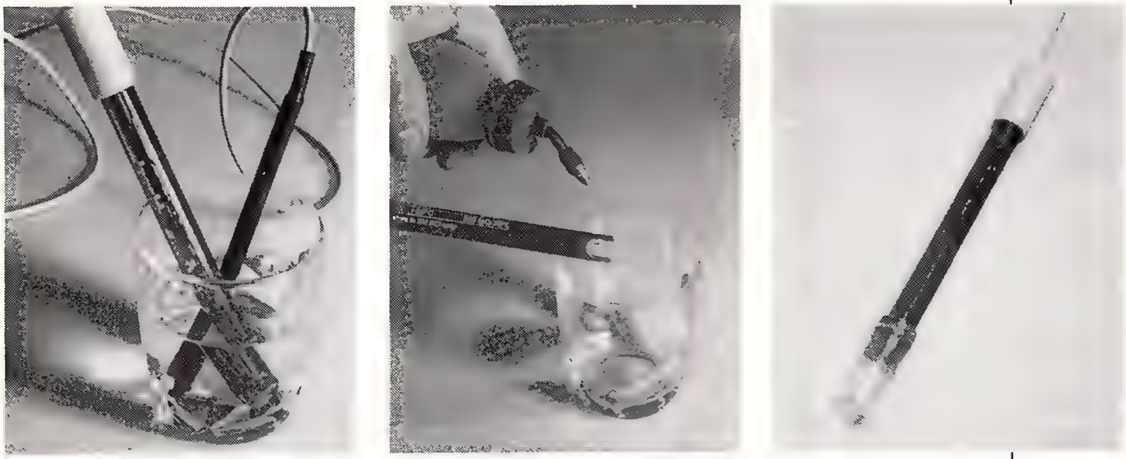
File some slots in the box for the presets so that these can be operated even when the box is closed.

Locate the stereo socket for the temperature sensor beside the battery compartment.

The wiring between the BNC socket and the board is fairly critical: use double-



It should not be done like that...



But like this...

Never use tap water!

- Before every measurement, take the temperature of the electrolyte to be measured. This is necessary because of the temperature-dependent behaviour of the sensor. The pH meter automatically compensates for temperature differences w.r.t. 25°C.
- Some electrolytes may discolour the glass membrane or the diaphragm. The suppliers of the sensor have available a variety of cleaning liquids for specific cases.
- At the extremes of the measuring range (around 0...2 and 12...14) a small metering error occurs which cannot be corrected. Over the remainder of the range, an accuracy of two per cent is attainable provided the calibration has been carried out correctly.

Finally, a few words about the life of the sensor. Filled with a gel as used here, it has a life of 1...3 years, depending on the number and type of measurements. The great advantage of this type of sensor lies in its ease of use: it only needs to be immersed in the electrolyte to be measured. There are, however, also separate measuring and reference electrodes available (which therefore make replacement of the buffer solutions possible), but these are much more cumbersome to use, although they have an appreciably longer life. They can also be given a new lease of life by being treated with special aqueous solutions. Against that, they are also considerably more expensive, so that in practice most hobbyists will invariably opt for the sensor used in this article.

Parts list

Resistors:

R1 = 270 k*
R2 = 100 k*
R3 = 1 M*
R4,R5,R7 . . . R9 = 1 M
R6 = 180 k
R10,R16 = 39 k*
R11,R12,R14 = 130 k*
R13,R15 = 91 k*
R17 = 47 k*
R18 = 470 k*
R19,R21 = 75 k*
R20 = 150 k*
R22 = 180 k*
R23 = 6k8*
P1 . . . P5 = 50 k ten-turn preset
* = 1% metal film

Capacitors:

C1 . . . C3 = 220 n
C4 = 100 p polystyrene
C5 = 4μ7/16 V
C6,C7 = 22 μ/16 V tantalum

Semiconductors:

D1 = 1N4148
T1,T2 = BC 550 C
IC1 = 7106
IC2 = TL084
IC3 = 4070
IC4 = 4066

Miscellaneous:

S1 = double-pole changeover switch
1 off pH sensor type U455; order no. 104553001 — BNC termination — (*Life Science Lab, Sarum Road, Luton LU3 2RA, Bedfordshire. Telephone: 0582 597676*)
1 off temperature sensor, type KTY-10-6 (old code KTY-10-A); KTY-81-210; KTY-81-220
1 off 3½ digit LCD display
1 off stereo 3.5 mm socket with built-in switch
1 off BNC socket
1 off 9 V power pack battery
1 off Verobox 65-2996H handheld box with switch cut-off, dimensions 145 x 80 x 36 mm
PCB 85024

2

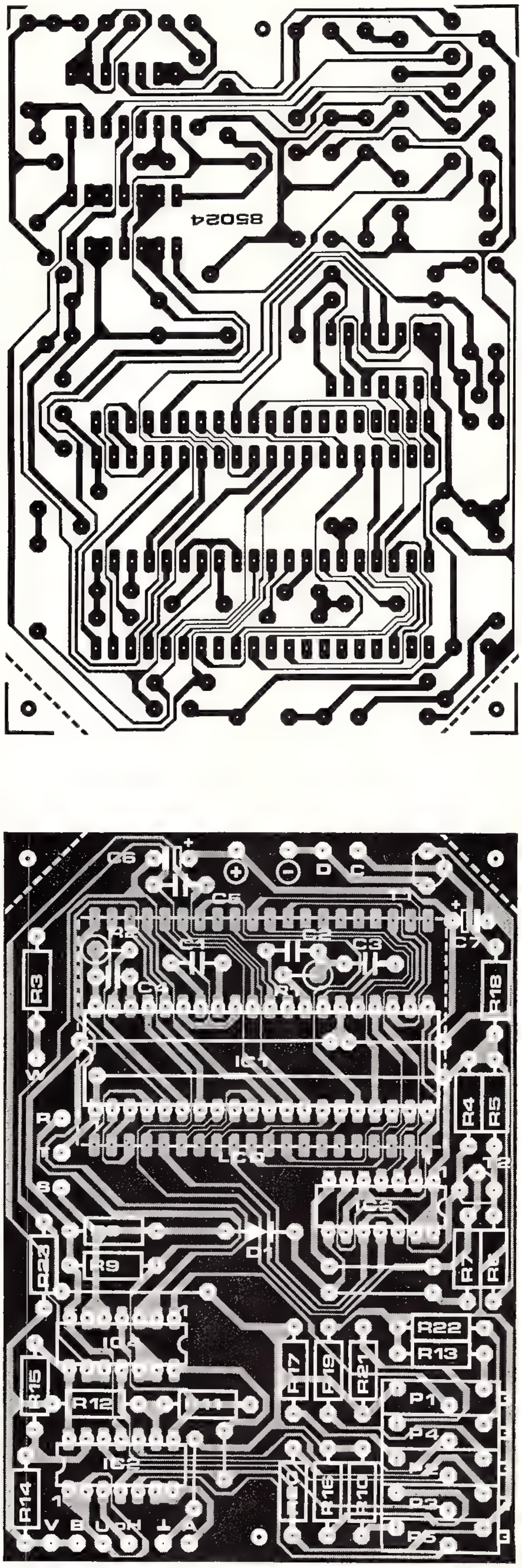


Figure 2. The printed circuit board of the pH meter. The LCD display is mounted at the track side. DO NOT use a 7106R for IC1 — only a 7106!

3

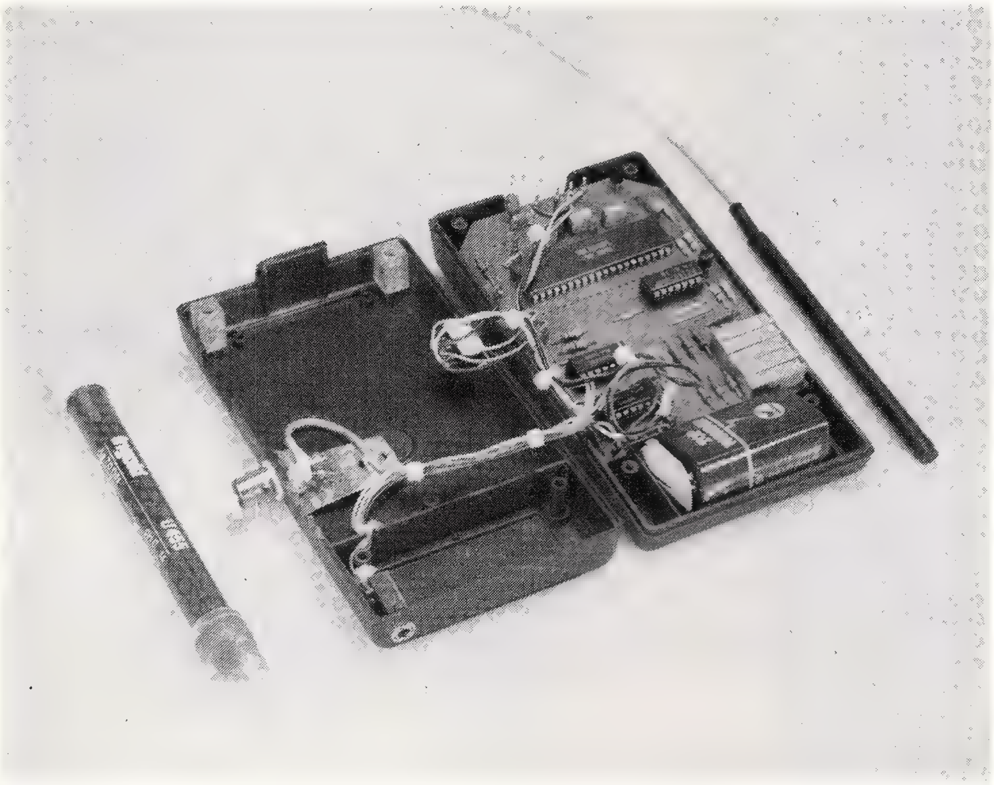


Figure 3. This photograph shows clearly how the meter is assembled in the case.

screened teflon cable and keep it as short as possible. This is vital because of the high isolation resistance required. All other connections may simply be made from flexible equipment wire.

If the pH sensor has not yet been fitted with a BNC plug, do so now. Fitting should be done with great care: the cable is of a special type with a very high isolation resistance.

The temperature sensor should be fitted with a length of standard single screened cable and then inserted into an empty ballpen holder which is subsequently filled with two-component araldite (an example of this may be seen in the photo of figure 3). The cable should then be fitted with a 3.5 mm stereo jack: screen to the housing and the conductor to the foremost section. The rear section is used for switching the supply voltage on and off.

Calibration

Buffer solutions with a pH of 4, 7, and 9 respectively are required for calibrating the meter; they are normally available from the suppliers of the sensor.

Set switch S1 to position 'temp' (V/R in figure 1). Place the temperature sensor in a mixture of water and crushed ice (stir well!), wait a few minutes and then adjust P2 to obtain a reading of exactly 1.69 V d.c. between the output of opamp A4 (pin 7) and earth. The display should then read 00.0. Next, place the sensor, together with a clinical thermometer, in a large bowl of water at about 37°C. Again wait a few minutes and then adjust P1 so that the display shows the same value as the thermometer.

Next, set S1 to position 'pH' (U/S in figure 1). Remove the protective cap from the pH sensor and thoroughly rinse the sensor in distilled water. Place the pH sensor and the temperature sensor in the buffer solution with a pH of 7, which should be at 25°C. Wait a few minutes and then adjust P3 to give a reading on the display of 7.00. Remove both sensors from the solution, rinse them thoroughly in distilled water, and then place them in the buffer solution with a pH of 4, which again should be at 25°C. Wait a few minutes, and then adjust P4 to give a display reading of 4.00. Remove both sensors from the solution, rinse them thoroughly in distilled water, and then place them in the buffer solution with a pH of 9. The display should then read 9.00; if not, slightly adjust P4, and repeat the pH 4 test. Finally, remove the sensors from the solution, rinse them thoroughly in distilled water, and then place them again in the solution with a pH of 7. The display should then read 7.00; if not, carefully repeat the above calibration.

The meter is now ready for use. It is advisable to calibrate it at regular intervals because of the ageing of the pH sensor. Calibration is also recommended before measurement when the meter has not been used for some time.

This concludes the description of the pH meter, but for those of you who are interested there follows a detailed account of the pH sensor. ◀

speech for microcomputers

phoneme synthesizer with Centronics input

Speech processing with personal computers is still a very costly and restricted affair. Fairly simple methods using your own spoken text need large memories and even then the results are modest. Industrial, and therefore much more expensive, computers don't do all that much better, although they sound better. The phoneme generator suggested in this article is relatively inexpensive and can be operated with a medium-sized memory.

A phoneme (Greek: 'speech sound') is a basic sound unit in a language. E.g. in English 't' and 'd' are separate phonemes; 'c' and 'k' may be the same or different (cider; caulk; kirk); 'c' and 's' may be the same or different (sirup; cork; civet); 'ph' and 'f' are the same.

The proposed phoneme generator is based on the type SPO 256 speech processor IC. We set out to produce a comprehensive construction plan, complete with pcb and application notes. But practical work with the circuit soon showed (as we should have known) that it's not as simple as all that: a pity, but on the other hand the SPO 256 is by far the cheapest IC of its kind on the market. If you want quick results ("Hurray, my computer can talk!"), you'll have to think again. This article is rather for those who are interested in experimenting with speech. It can teach you a lot about the structure of spoken language and the programming of a phoneme synthesizer. A little experience in the art of phoneme arranging can give much enjoyment in coming to grips with the principle of speech deliverance.

Phonemes and sounds

From the definition of a phoneme it is evident that any word in a language can be broken down into a number of phonemes. The word 'man', for instance, consists of the phonemes 'm', 'a', and 'n'. But here again, difficulties arise, particularly in English, for there are twenty-six basic letters in the English alphabet, but over forty basic sounds. The English language gets around this problem by using the same letter or letters for different sounds, as in the many ways in which the *ough* combination can be pronounced; and it gives the same sound all sorts of different meanings and spellings: the same vowel<i> appears in *sit, women, village, busy* and *enough,* for instance. Then there are *pear, pair,* and *pare; site, sight,* and *cite; so, sew,* and *sow; caught* and *court; father* and *farther.* German has the same in, for instance, *sein* and *sein* ('to be' and 'his'); *Wetter* and *Wetter* ('punter' and 'weather'); and French in *père, pair, paire* ('father', 'peer', 'pair'); *sûr* and *sur* ('sure' and 'on'), and *sot* and *seau* ('foolish' and 'bucket').

Table 1.

Table 1. Correlation between phoneme code, allophone, phoneme duration, and respresentative sound.

phoneme			representative sound (bold letters)
decimal code	allophone	duration (ms)	
00		10	pause
01		20	pause
02		50	pause
03		100	pause
04		200	pause
05	OY	290	boy
06	AY	170	five
07	EH	50	left
08	KK3	80	count
09	PP	150	peak
10	JH	100	jump
11	NN1	170	none
12	IH	50	it
13	TT2	100	to
14	RR1	130	right
15	AX	50	trouble
16	MM	180	magnet
17	TT1	80	part
18	DH1	140	they
19	IY	170	see
20	EY	200	stay
21	DD1	50	card
22	UW1	60	computer
23	AO	70	long
24	AA	60	hot
25	YY2	130	yard
26	AE	80	man
27	HH1	90	he
28	BB1	40	trouble
29	TH	130	thin
30	UH	70	push-pull
31	UW2	170	food
32	AW	250	south
33	DD2	250	do
34	GG3	120	jig
35	VV	130	very
36	GG1	80	go
37	SH	120	shift
38	ZH	130	measure
39	RR2	80	bring
40	FF	110	for
41	KK2	140	skip
42	KK1	120	ask
43	ZZ	150	zero
44	NG	200	talking
45	LL	80	look
46	WW	140	wire
47	XR	250	dear
48	WH	150	where
49	YY1	90	yes
50	CH	150	chip
51	ER1	110	counter
52	ER2	210	turn
53	OW	170	slow
54	DH2	180	lathe
55	SS	60	stop
56	NN2	140	no
57	HH2	130	hertz
58	OR	240	store
59	AR	200	arm
60	YR	250	clear
61	GG2	80	glue
62	EL	140	angle
63	BB2	60	bit

An allophone (Greek: 'other sound') is one of the variant sounds forming a phoneme.

If a word can be broken down into phonemes, it should be possible to build up words from phonemes and it is this consideration, of course, that lead to the concept of speech production by microprocessor. From the above examples it is evident that speech production by microprocessor is immeasurably easier than speech recognition. We must bear in mind, however, that if a computer utters the word *rain*, it could actually mean *reign*; which of the two can only be assessed by the context in which it is used. The human brain can cope; but then it has a memory besides which even the most powerful computer memories pale into absolute insignificance. You will also see the enormous problems still to be resolved before we can hope to produce a computer that can differentiate between *taut* and *taught* or between *Mona* and *moaner*. None the less, in theory at least, if the memory of a computer is loaded with the forty-odd phonemes of the English language, it should be able to produce all the words contained in our language — given a suitable speech processor, of course.

The SPO256 as phoneme synthesizer

The prototype of the SPO256 introduced some years ago was not really a phoneme sythesizer, but rather a speech card shrunk onto a chip with a word store in ROM. The later version, the SPO256-AL2, is, however, since its internal ROM con-

Table 2.

Table 2. Example of a simple sentence, the corresponding phonemes, and the relevant BASIC program.

hello	27-07-45-53-02
this	18-12-55-04
is	12-55-04
the	18-19-04
elektor	19-45-07-08-13-58-04
speech	55-09-19-50-04
card	08-59-21-02

```
 10   for K = 1 0 35 step 1
 20   restore 60
 30   read I
 40   LPrint CHR$(I)
 50   next K: end
 60   data 27, 07, 45, 53, 02
 70   data 18, 12, 55, 04
 80   data 12, 55, 04
 90   data 18, 19, 04
100   data 19, 45, 07, 08, 13, 58, 04
110   data 55, 09, 19, 50, 04
120   data 08, 59, 21, 02
```

1

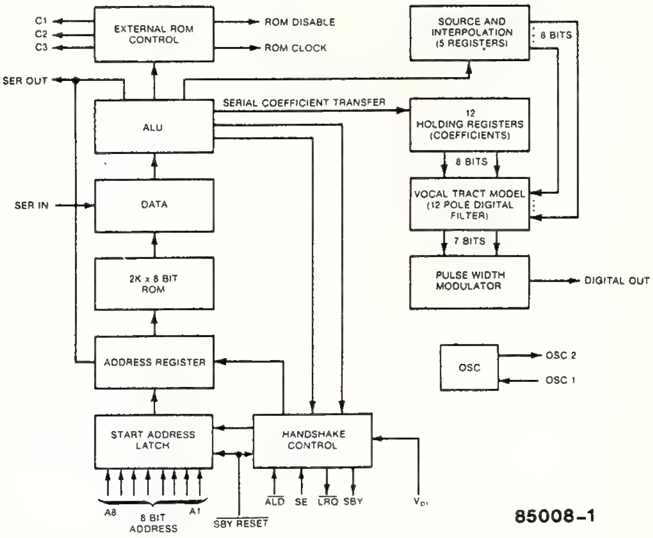


Figure 1. Block diagram of the single-chip NMOS speech processor type SPO256-AL2. The 2 K ROM of this new version contains information for the generation of sixty-four different phonemes.

2

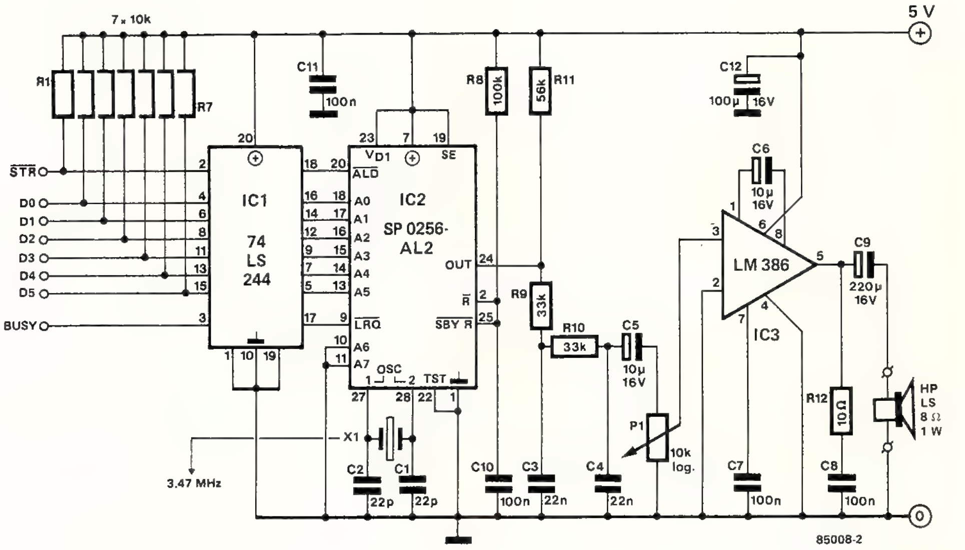


Figure 2. Circuit diagram of the complete experimental phoneme synthesizer.

3

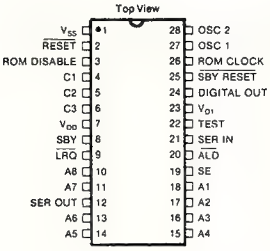


Figure 3. The pin configuration of the SPO256-AL2.

tains data for phonemes instead of for a certain number of words. This is also a very economical chip, because it is used in vast quantities in many industrial applications — with a different ROM content. Integrated circuits developed specially for use as phoneme generators, e.g. the SC01 produced by Votrax, are considerably more expensive, although to our ears this IC produces a clearer, albeit American rather than English, sound. This American influence is also evident in the SPO256-AL2 which stores fifty-nine phonemes, listed in table 1, although English linguistics and phonetics recognize only forty-odd phonemes in the **Received Standard**. This is a pronunciation of English which gives little or no clue to the speaker's regional affiliations.

The synthesis of words from phonemes is comparable to a jigsaw puzzle. Particularly in the beginning it seems almost impossible to get the correct phoneme, but after a while your ear will become attuned and word formation is then feasible.

The block diagram of the SPO256-AL2 is given in figure 1. The data for the phonemes are stored in a 2 K ROM. The synthesizer, which consists of a twelve-pole digital filter and a five-register generator, is controlled by addressed data. The phoneme data determine on the one hand which raw sound material is required from the generator, and on the other with which filter coefficient this sound must be processed. The digital, filtered signal is converted externally into a pulse-width modulated analogue signal.

Example of application

All necessary hardware is shown schematically in figure 2. The input of the small circuit can be connected to any standard Centronics interface. As only the phoneme data are transferred, the total data flow is very small. On average, eight bytes are sufficient for one second's speech. The phonemes (speech signal) generated by IC2 are available at pin 24 as a digital signal. A small external low-pass filter converts this into an acceptable analogue signal. The required sound volume is provided by IC3, a simple audio amplifier of the well-known type LM 386.

Programming is relatively simple: all you have to do is to write in the appropriate phoneme code from the list in table 1. These data are then transferred to the print interface by LPrint. As an example, the sentence 'this is the elektor speech card' and the relevant phonemes are given in the upper half of table 2, while the corresponding BASIC program is listed in the lower half.

This is only a small example, but we hope that you will soon progress to bigger things! Have fun! ◆

Literature

talk to computers by H P Baumann, *Elektor*, May 1981, p. 5-17
talking board, Elektor, December 1981, p. 12-04

missing link

tuning fork

(October 1984, page 10-26)

On page 10-28, second column, lines 10...13
C12/C13/R40 should read C12/C13/R37
C14/C15/R41 should read C14/C15/R38
D36 should read D2
D37 should read D3

digital band-pass filter

(July/August 1984, page 7-48)

Resistor R19 should be connected in series with additional capacitor of 1 μF between pin 13 of IC1 (− input of A4) and earth: this will raise the Q factor to its required value.
the times stated at the output waveforms of the two monostables are the periods of the input pulses and not of the output signals.

flash meter

(September 1984, page 9-36)

There are some stubborn cases defying our previous solution to problems caused by leakage currents. If you are experiencing these, remove pin 3 of IC6 from its socket, unsolder all connections to this point on the pcb and remake them 'in the air' direct to pin 3. Use short lengths of insulated wire. The other side of DIL switches S5...S8 and the corresponding terminals of C8...C11 should also be unsoldered from the pcb and remade 'in the air' with short lengths of insulated wire.

service

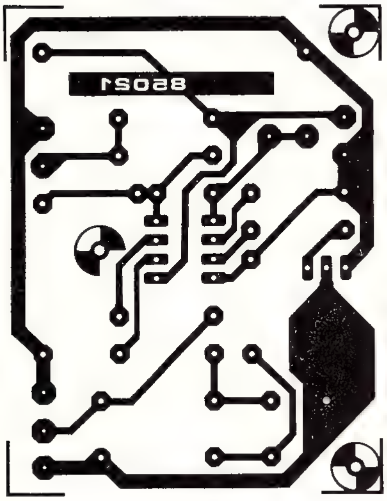
DANGER! Ultra-violet light is harmful to your eyes, so when working with a mercury vapour lamp, wear some form of *effective* eye protection.

How to make your own PCBs

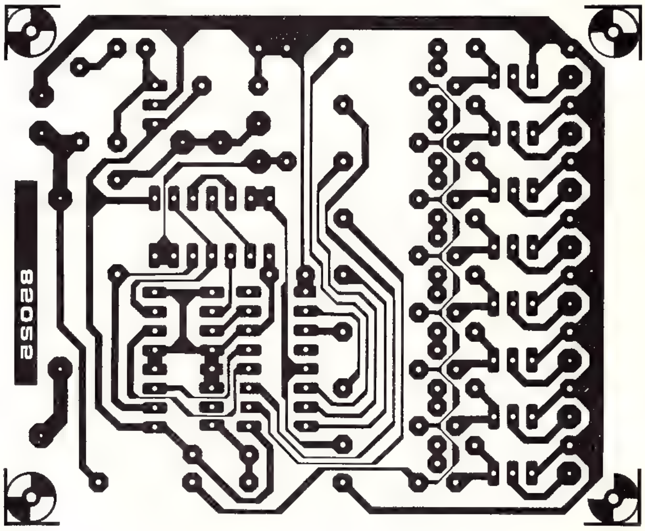
You require an aerosol of 'ISOdraft' transparentizer (distributors for the UK: Cannon & Wrin, 68 High St., Chislehurst, Kent, 01 467 0935, who will supply the name and address of your local stockist on request), a mercury vapour lamp, sodium hydroxide (caustic soda), ferric chloride, positive photo-sensitive board material (which can be either bought or home made by applying a film of photo-copying lacquer to normal board material).

- Wet the photo-sensitive (track) side of the board thoroughly with the transparant spray.
- Lay the layout cut from the relevant page of this magazine with its printed side onto the wet board. Remove any air bubbles by carefully 'ironing' the cut-out with some tissue paper.
- The whole can now be exposed to ultra-violet light.
- The exposure time is dependent upon the ultra-violet lamp used, the distance of the lamp from the board, and the photo-sensitive board. If you use a 300 watt UV lamp at a distance of about 40 cm from the board and a sheet of perspex, an exposure time of 4 . . . 8 minutes should normally be sufficient.
- After exposure, remove the layout sheet (which can be used again), and rinse the board thoroughly under running water.
- After the photo-sensitive film has been developed in a sodium hydroxide solution (about 9 grammes of caustic soda to one litre of water) for no more than 2½ . . . 3 mins at 20°C, the board can be etched in ferric chloride (500 grammes of $FeCl_3$ to one litre of water). Then rinse the board (and your hands!) thoroughly under running water. It is advisable to wear rubber or plastic gloves when working with caustic soda or ferric chloride solutions.
- Remove the photo-sensitive film from the copper tracks with wire wool and drill the holes.

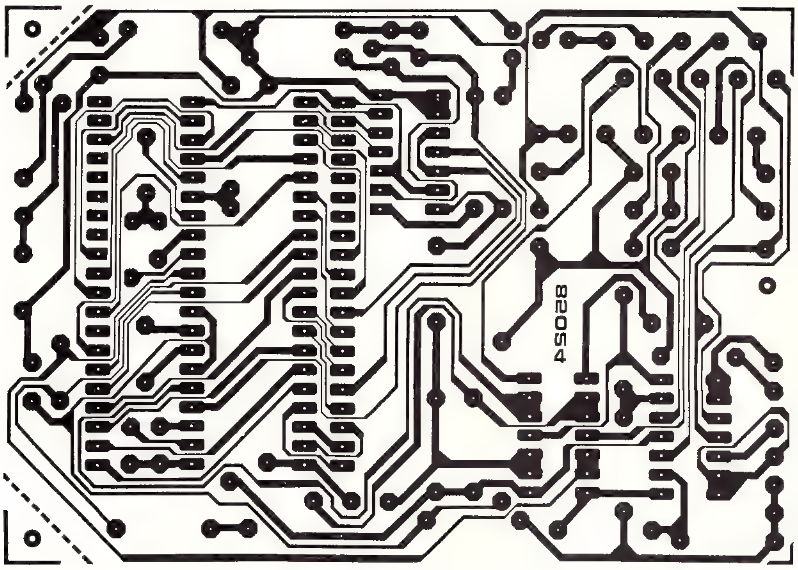
85021 — darkness-sensitive light switch



85025 — KITT scanner

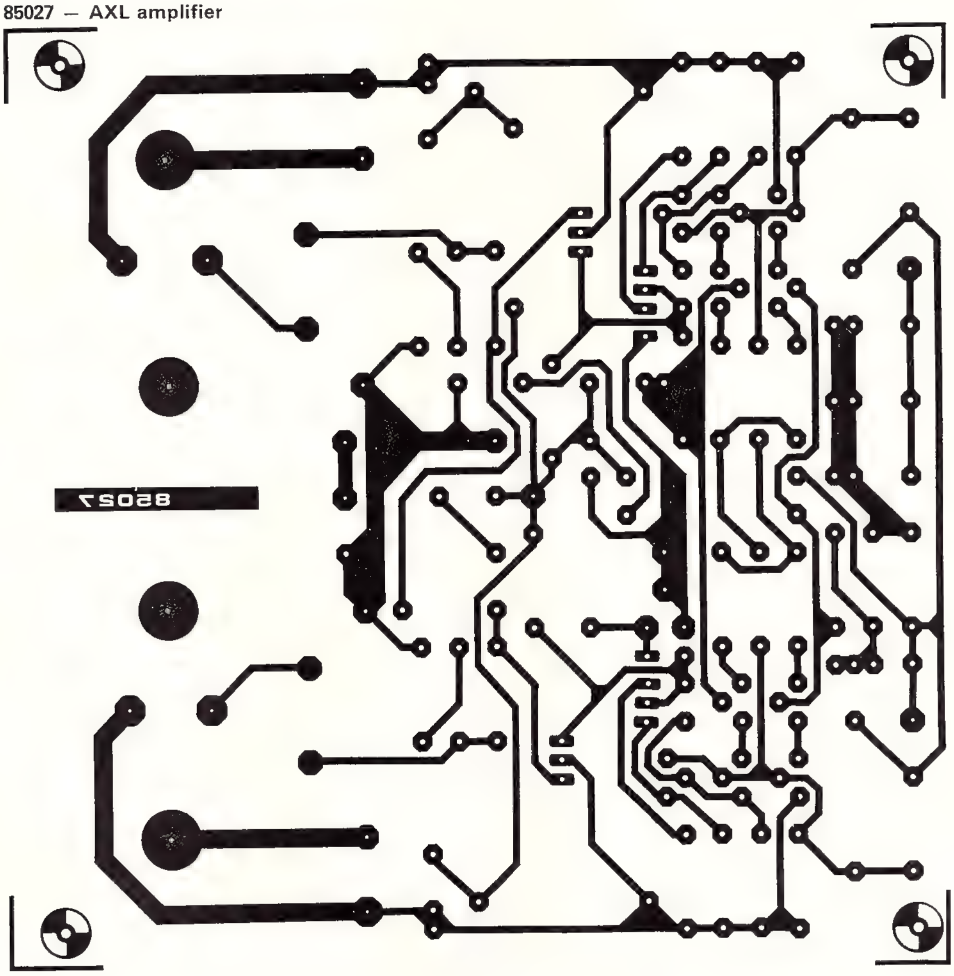


85024 — pH meter

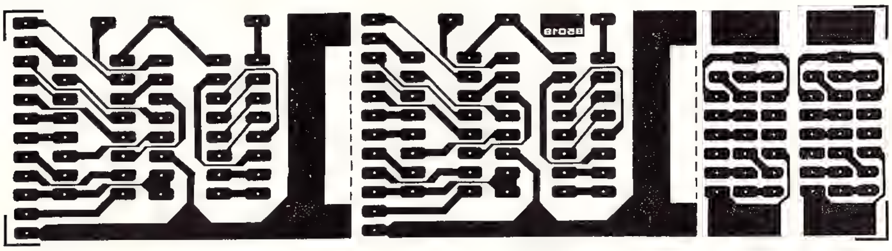


service

85027 — AXL amplifier

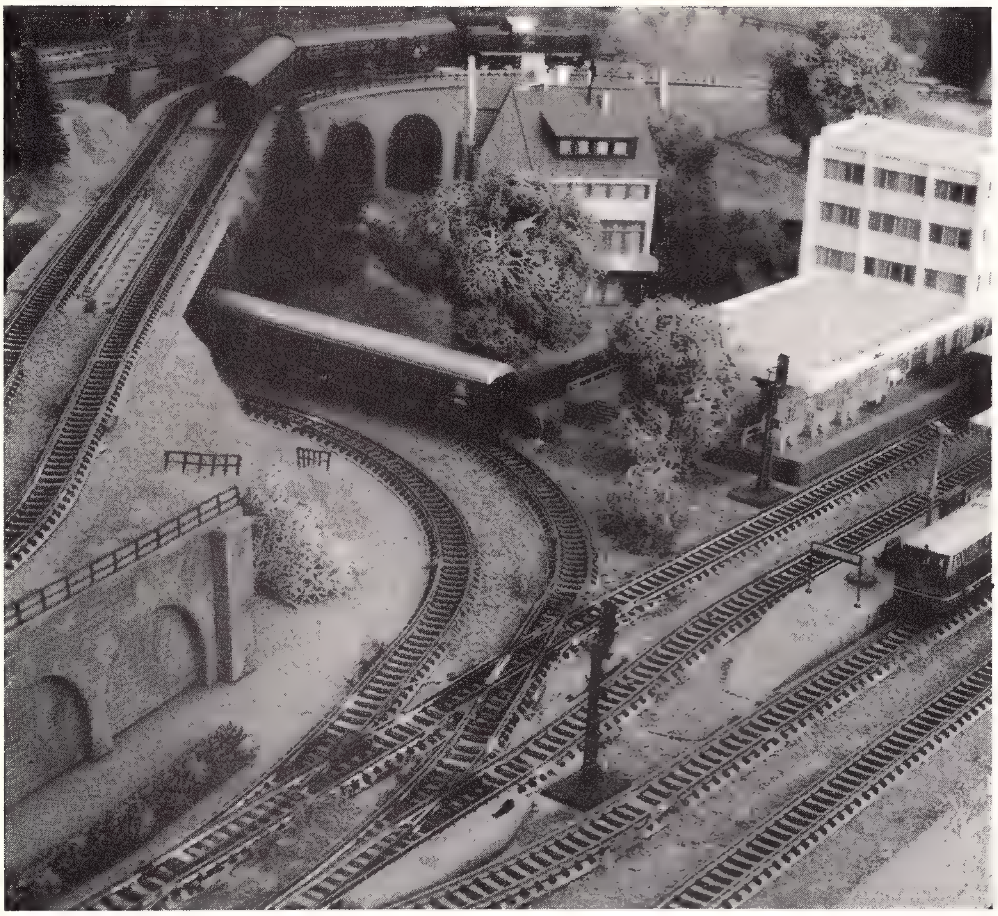


85019 — versatile counter module



service

PC board pages



with or without
a computer

turnout (points) control

Turnouts (points) are usually controlled remotely by the use of electro-magnetic drives (solenoids) which are operated by short pulses of current. In practice things sometimes go wrong and the pulses of current will cause the solenoids to go literally up in smoke. The electronic drive and power supply described in this article can prevent such disasters.

As long as the turnouts in a model railway are remotely controlled by hand, the risk of damage to the solenoid is small: you will note almost immediately whether the coil goes on humming when the voltage has not been switched off in time. Nowadays, it is not too difficult to automate any model railway by a microprocessor. This implies immediately, however, that much more stringent requirements must be met by the turnout control circuits, because the computer cannot hear, see, or smell. This seems an excellent reason to have a critical look at the control of electric turnouts. At the end of this article we will give our imagination free rein and see what a computer-controlled model railway would look like and, particularly, how such a model could be realized.

Turnouts

Manufacturers of electro-magnetic drives assume that the solenoid will only get a short pulse of current, sufficient to change over the turnout: no current is required to keep it in its new position. Relatively speaking, the change-over of a turnout requires considerable power and because of that a large current flows through the solenoid. If that current continues to flow for some time, the resulting heat will cause the insulation of the coil to melt. The change-over of turnouts is therefore often effected by switches with spring-loaded contacts, which cannot, however, guarantee that the pulse of current is short enough, because it is possible that the switch is pressed too long or that the switch contacts stick owing to a defect. To prevent such mishaps, most turnouts are provided with a micro-switch that cuts off the current to the solenoid as soon as the turnout has changed over. This is the sum total of safety precautions provided by most manufacturers.

There are, however, other causes for mishaps. The most common is that owing to insufficient current the drive does not

1

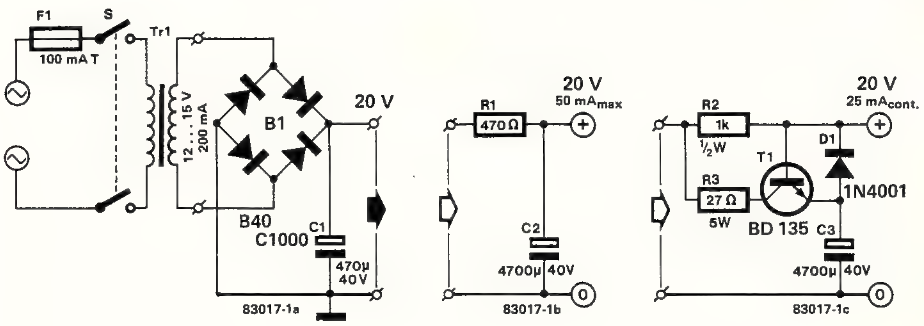


Figure 1. To prevent the burning out of a turnout solenoid that is driven by a power supply as shown in figure 1a, simple protection circuits as shown in figures 1b and 1c should be added. The current to the solenoid is then limited by R1 or R2: during switching the energy from C2 or C3 is used. The extension in 1c affords more protection than that in 1b. When the power supply so extended is loaded with a solenoid, T1 is off and only the charge of C3 is used for changing over the turnout. Only after the solenoid has been switched off can C3 recharge (rapidly) via T1.

reach the other side or clatters against it. In either case, the micro-switch does not come into operation and the consequences may be disastrous. More safety precautions are therefore necessary and these can be provided by electronics.

Power supply for turnouts

A suitable power supply of conventional configuration is shown in figure la. To limit the current through the solenoids, a resistor may be connected in series with the +20 V line as shown in figure lb. The power supply solves the problem of short-circuits (and the consequent very high currents) in a simple way. To ensure that a sufficiently high current is fed to the solenoid, an electrolytic capacitor, C2, is connected after the series resistor, Rl. By experimenting with the value of the capacitor (the value shown was right for our purposes), it is possible to match the pulse energy with the requirement of the particular type (brand) of solenoid.

But even this circuit has drawbacks. The short-circuit current of 50 mA may still be too high, and it takes a relatively long time after a pulse of current before C2 has recharged sufficiently to enable turnouts to be operated. The value of the short-circuit current cannot be reduced by increasing the value of Rl because this will lengthen the recovery time of C2. Nor can the recovery time be shortened by reducing the value of Rl, because then the value of the short-circuit current becomes too high.

There are two solutions to this problem. The simpler is connecting a series resistor and buffer capacitor in the supply to each turnout (one transformer can power many turnouts because energy is only required in short bursts). The recovery time is then still too long to enable quick successive operations of one turnout, but all other turnouts can be operated (alomost) simultaneously. This solution is best suited to those systems where further automation is planned, because only one particular turnout is normally changed over between two trains.

The second solution is of particular use where manual control of turnouts is intended to be retained. It consists of extending the power supply by the circuit of figure lc instead of that in figure lb. The recovery time is then much shorter, about one second, so that only one series resistor and buffer capacitor need to be used to control all turnouts. This solution is not suitable for automation because it does not allow the simultaneous operation of a number of turnouts (as the pulse of current becomes too weak).

2

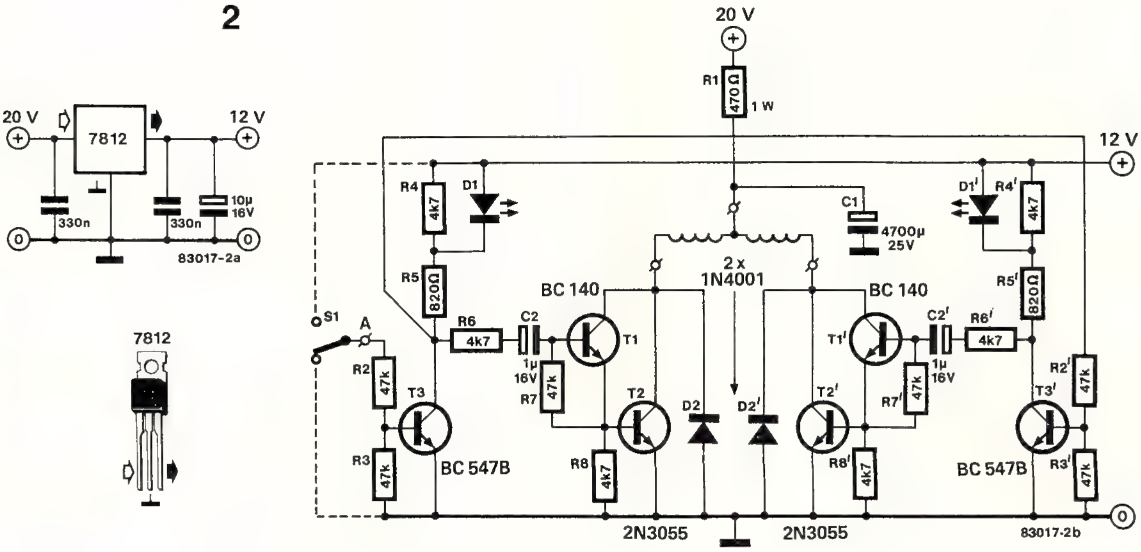


Figure 2. This electronic switch is intended for switching turnouts. When S1 is changed over, T1 and T2 (or T1' and T2', as the case may be) are turned on briefly. This causes the solenoid to be energized and the turnout changes over.

3

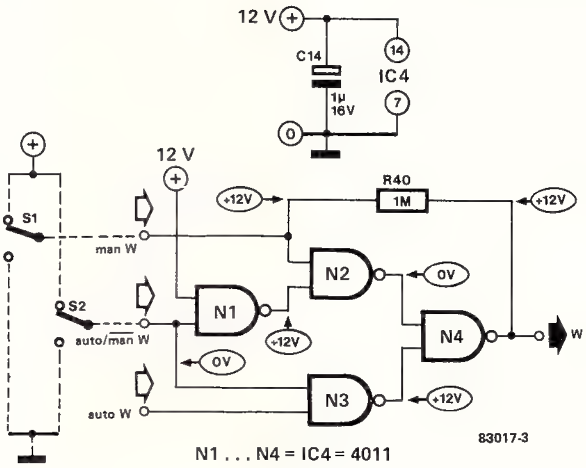


Figure 3. This circuit makes turnout control really interesting. It makes it possible to choose between manual control or automatic control by computer.

Control electronics

The use of push-button switches with spring-loaded contacts for the control of turnouts is now no longer necessary. Instead, a simple change-over (toggle) switch is used: S1 in figure 2. The circuit in this figure generates a pulse of current in one of the two turnout coils every time S1 is changed over and the input is consequently switched between 0 and 12 V. The position of the turnouts is indicated by LEDs D1 and D1'.

Although no precaution is one hundred per cent reliable, it is highly unlikely that the solenoids will burn out. After all, there are three safety precautions: the supply current is limited by R1 and C1; R6 and C2 ensure that transistors T1 and T2 are on for only a brief moment, and there is still the turnout's own safety switch.

The stabilizer circuit shown in figure 2a needs to be built only once: it is capable of driving some ten turnouts; and even fifty if a 1 A transformer is used and C1 is given a value of 2000 μF!

Automation

The circuit has already become very useful because manual control of the turnouts has become much more reliable. By adding a further extension, it becomes possible to switch between manual and automatic control, as shown in figure 3. There is now an 'auto/man' input which is shown for 'automatic' operation.

The turnout signal 'auto W' is passed on and if the output of N4 is connected with the input (terminal A) of figure 2, the position of the turnout is determined by the 'auto W' signal. Note that switch S1 in figure 2 is now located at the 'man W' terminal of figure 3. The 'auto W' signal is generated by the computer that controls the model railway. Note that the computer is powered by +5 V and the circuit in figure 3 by +12 V. This requires level matching which can, for instance, be effected with an open-collector gate.

Computer control

The last paragraph dealt with computer control, but here we must disappoint you: it is not (yet) possible to present a fully computer-controlled model railway in a few pages. We have, however, decided, as with the Junior computer, the TV games computer, and the Formant, to publish all the required information in a book to be published this spring: 'Automate your model railway'. You may well ask yourself: "For whom is that book intended? Does one have to be a computer specialist or is it suitable for the interested layman?"

To answer those questions, it is sensible to ruminate on what is involved in automating a model railway.

In the first place, trains must be able to travel. This requires a power controller, preferably a good one that allows slow starts and pull-ups. Such a controller is and remains indispensable, whether the railway is controlled by hand or by computer.

Reliable turnout control, as we have seen above, is of prime importance.

A further requirement is the division of the railway into blocks and sections and the addition of colour light signals. At this stage it is also sensible to incorporate protection circuits, irrespective of whether the movement of the trains is determined by man or by machine. If the protection circuits are electronic rather than mechanical (i.e. relays as recommended by many manufacturers), the reliability factor is further increased appreciably.

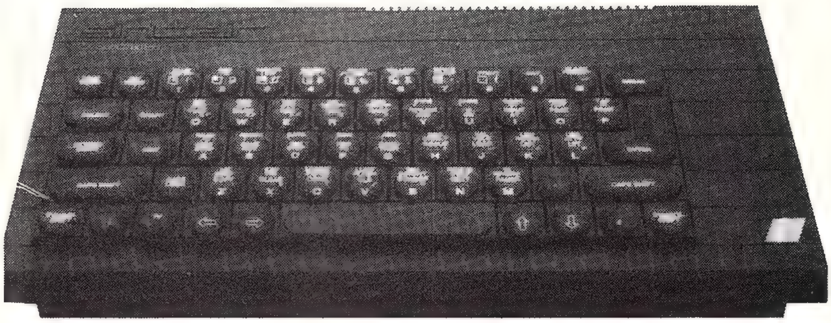
Only when the above points have been attended to does it become sensible to consider the addition of a microprocessor to control the entire system. The result of that addition will be a railway on which trains, in some mysterious fashion, move along the tracks without mishap and (apparently) without needing human help. In that sense, it is possible to build the model railway in steps. Each step in itself is sensible, irrespective of whether further automation is contemplated or not. This approach makes it possible to go as far as personal taste or bank account or both allow.

To be honest, the book starts with a power controller which has been kept sufficiently simple to allow anyone building it successfully. On the other hand, the last chapter dealing with how the Junior computer can control the system takes a little longer to digest. But, of course, by the time you get there, you have that much more knowledge and experience!

The final question may well be whether it is a good thing to automate a model railway. Unfortunately, this cannot be answered with a simple yes or no. There are hobbyists who immediately upon completing a project dismantle it to start afresh. Others do nothing but write new timetables. In the same way, there are proponents and opponents of computer control of a model railway. ◀

When Sinclair introduced a new Spectrum last autumn, they at last acknowledged that the poor keyboard on the old Spectrum was allowing the competition to take over slices of what had been a safe Sinclair market for some time. It is gratifying to see that they have finally decided to right this abomination.
The new machine is type-coded Spectrum+ and is a much more user-friendly unit that can stand comparison with any other computer in its price class. Its faint resemblance with its bigger brother, the QL, gives it an impression of solidity. Inside it has remained very much the same. And why not? Apart from its miserable keyboard, the old Spectrum, with its wide-ranging BASIC and its really useful graphics, was one of the best-value-for-money home computers around.

new keyboard for Spectrum...



...makes programming easier

The noteworthy aspects of the new keyboard are not just the much easier to operate keys, but also a large number of single-key operations, which on the old Spectrum were only available by pressing more than one key at the same time. This makes programming and particularly editing a lot easier.
If you have an old Spectrum and would like the facilities of the Spectrum+, without buying the new version, the circuit suggested here is for you.

The new keyboard

The layout of the new keyboard is shown in figure 1. All keys of the old keyboard have been retained, and new ones have been added as follows:
Top row: TRUE VIDEO; INVERT VIDEO; BREAK
Second row: DELETE; GRAPHIC
Third row: EXTEND MODE; EDIT
Fourth row: FULL STOP
Bottom row: SEMICOLON; DOUBLE QUOTATION MARKS; four CURSOR keys; COMMA
Other novelties are that the CAPS SHIFT and SYMBOL SHIFT have been duplicated at the left-hand and right-hand side, and that the SPACE bar has been centred and made wider.

Operation

How Sinclair has solved the problem of the additional keys is of little interest here, as we had designed the present circuit before the Spectrum+ had been announced.
Figure 2 shows what the Spectrum looks like when the keyboard cover and the conductive silicone rubber sheet directly underneath it have been removed. The circuit diagram of the 8 by 5 scanner matrix that has become visible is shown in figure 3. Each switch shown in the diagram represents a key contact. The numbering is arbitrary and has no special significance. This matrix is also present in our proposed new keyboard, with the difference, however, that the touch-keys have been replaced by full-size keys: this gives a feel that is similar to that of a typewriter and entry speed is, therefore, much higher and much more reliable. The second CAPS SHIFT and SYMBOL SHIFT keys have simply been wired in parallel with the original ones.
The old keys that need no additional or new electronic circuitry are called 'A' keys in figure 4.
The key contacts in figure 3 are controlled without any problem by CMOS switches. These switches are at the heart of our design: any of the additional keys operates two or more CMOS switches simultaneously. If we now consider the 'B' keys in figure 3, we see that all functions controlled by contacts S41...S51 have this in common: the CAPS SHIFT key must be pressed at the same time as another key. It is therefore necessary that each key contact is connected to a CMOS switch

1

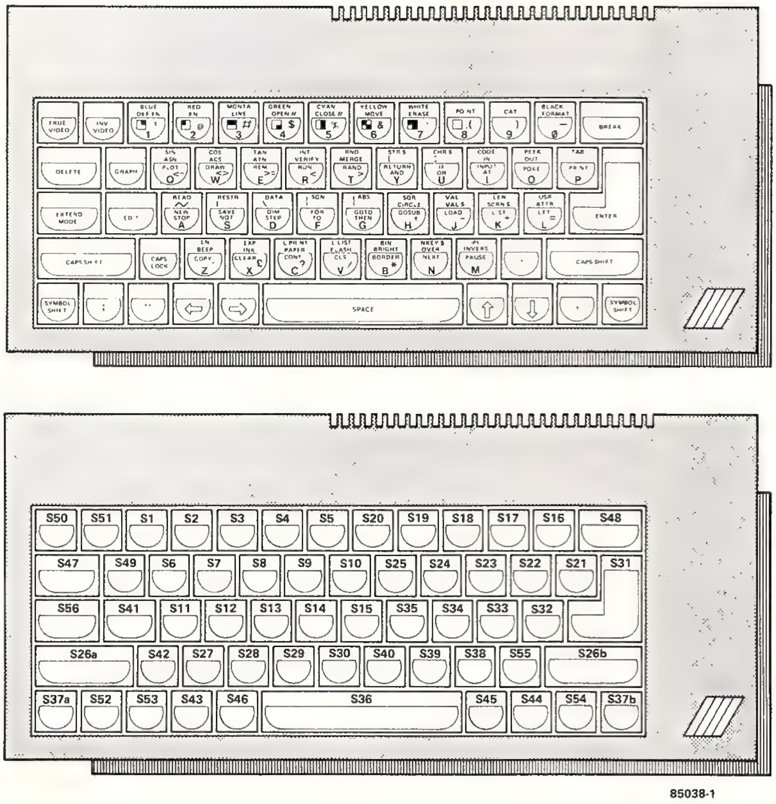


Figure 1. Layout of the proposed new Spectrum keyboard, with all the old keys retained in their original position. The newly added keys do not represent new instructions or functions, but enable single-key operation where before more than one key had to be pressed. Note the enlarged ENTER key, the duplication of the CAPS SHIFT and SYMBOL SHIFT keys, and the much better location of the SPACE bar.

2

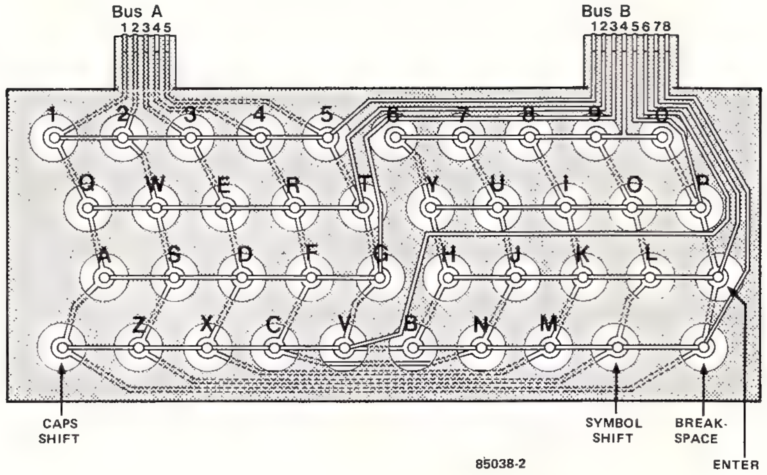


Figure 2. Once the lid and conductive silicone rubber sheet have been lifted off the keyboard, the scanner matrix becomes visible. Connections A1. . .A5 and B1. . .B8 are identical to those on the circuit diagram. The new keyboard is connected in exactly the same way as the old one: this is best done with ribbon cable which is soldered at the underside of the computer board in place of the obsolescent socket.

(ES) that is connected in parallel with the CAPS SHIFT contact on the 8 by 5 matrix, and to a switch that is connected in parallel with the relevant original key contact. For example, to carry out the operation 'edit', it is necessary to actuate the '1' and the CAPS SHIFT keys. The former is effected by ES2, and the latter by ES1 (which interconnects the A1 and B1 bus lines). All CMOS switches, except those that operate the CAPS SHIFT and SYMBOL SHIFT keys, are controlled via delay networks. This is necessary to ensure that at all times the CAPS SHIFT or SYMBOL SHIFT contact is operated first. The diodes are decoupling devices and should not be omitted, otherwise erroneous operation may ensue.
Keys S52. . .S55, the 'C' keys, operate similary to S41. . .S51, except that here the

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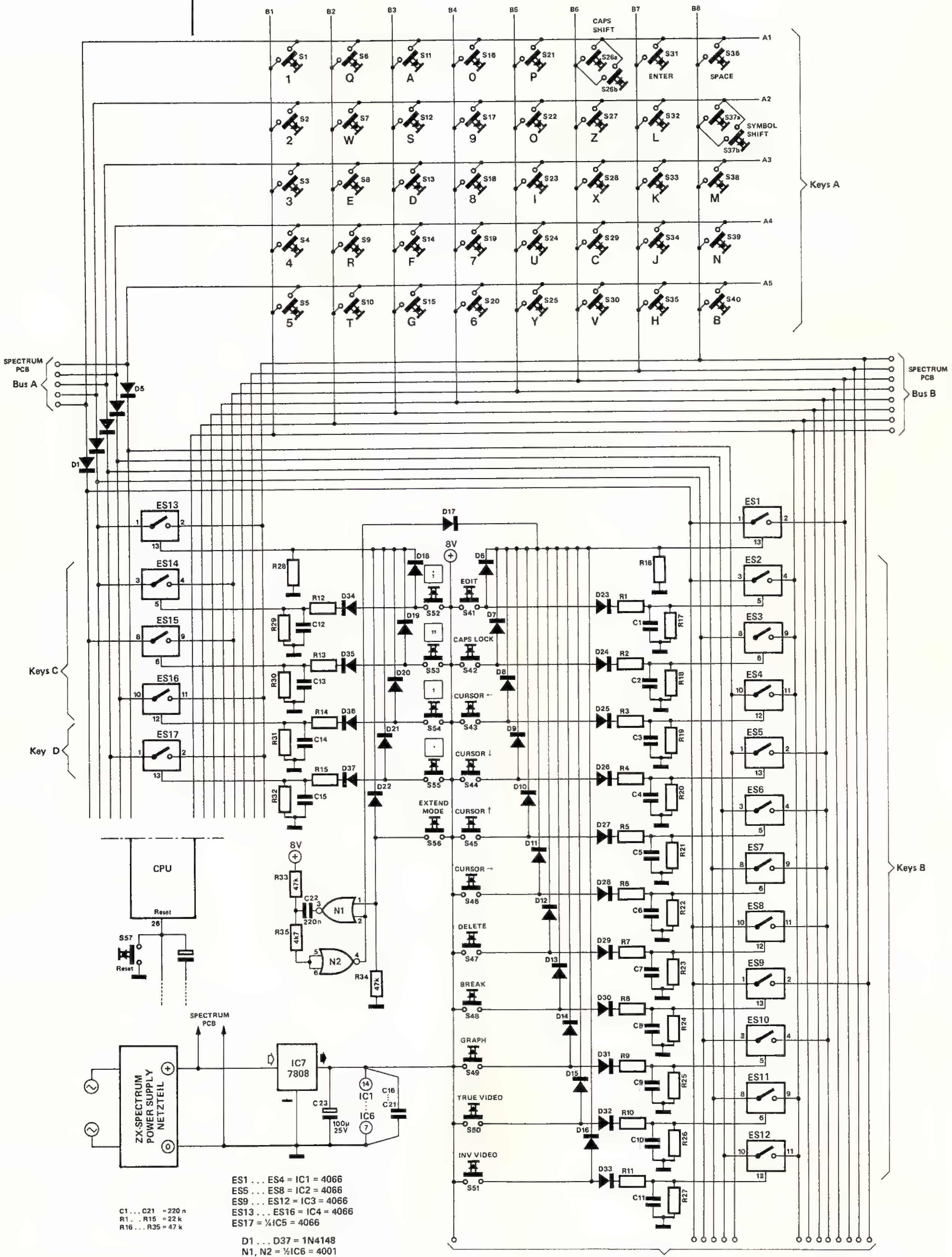


C1 . . . C21 = 220 n
R1 . . . R15 = 22 k
R16 . . . R35 = 47 k

ES1 . . . ES4 = IC1 = 4066
ES5 . . . ES8 = IC2 = 4066
ES9 . . . ES12 = IC3 = 4066
ES13 . . . ES16 = IC4 = 4066
ES17 = ¼IC5 = 4066

D1 . . . D37 = 1N4148
N1, N2 = ½IC6 = 4001

Figure 3. The circuit diagram of the new keyboard. The CMOS switches and associated components may be mounted on a eurocard. S57 is a RESET switch.

4

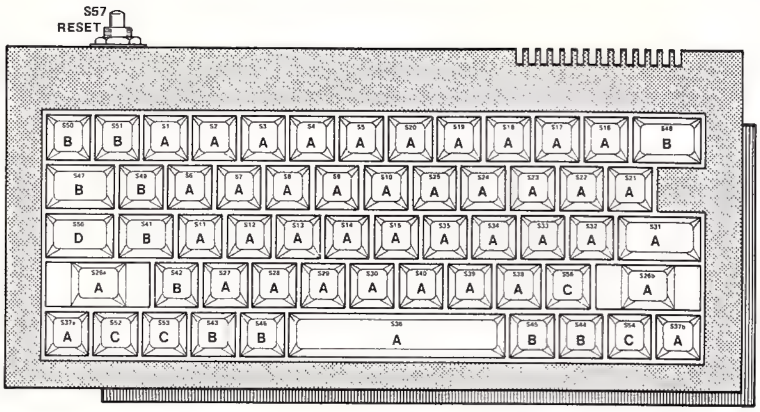


Figure 4. Identifying the single key switches by A...D makes it clear that from a purely electronics point the keyboard may be considered in four parts: (1) keys A, which are unaltered; (2) keys B, which control functions for which on the old keyboard the CAPS SHIFT key had to be operated at the same time; (3) keys C, which control functions for which on the old keyboard the SYMBOL SHIFT key had to be pressed at the same time; (4) key D, which actuates either the lower case (red) functions or the upper case (green) ones.

SYMBOL SHIFT key instead of the CAPS SHIFT key is actuated (by ES13). With the help of figures 1 and 3 it is possible to realize any function you want by using further keys and CMOS switches. The proposed circuit follows the keyboard of the Spectrum+, however, although many of you may find the VIDEO keys rather an unnecessary luxury which are better replaced by COLON (:) and SOLIDUS (/) respectively.

Extend mode key

The EXTEND MODE key, the 'D' key, is somewhat different from those described sofar. To jog your memory: if you want to use instructions printed in green (old keyboard), it is necessary to press the CAPS SHIFT and SYMBOL SHIFT keys simultaneously, release them, and then press the appropriate command key. If you want to use red instructions, the situation is even worse: you then have to press the SYMBOL SHIFT key, holds this down, and then press the instruction key. These problems are resolved by the EXTEND MODE key, S56. This switch is connected to ES1 (CAPS SHIFT) via monostable N1/N2, and to ES13 (SYMBOL SHIFT) via D22. When S56 is held down when the instruction key is pressed, the monostable formed by N1 and N2 opens the CAPS SHIFT key contacts after a very short time: the 'lower case' (red) instructions are then available. If, however, S56 is pressed and then released before the instruction key is pressed, the upper case (green) instructions become available.

Power supply

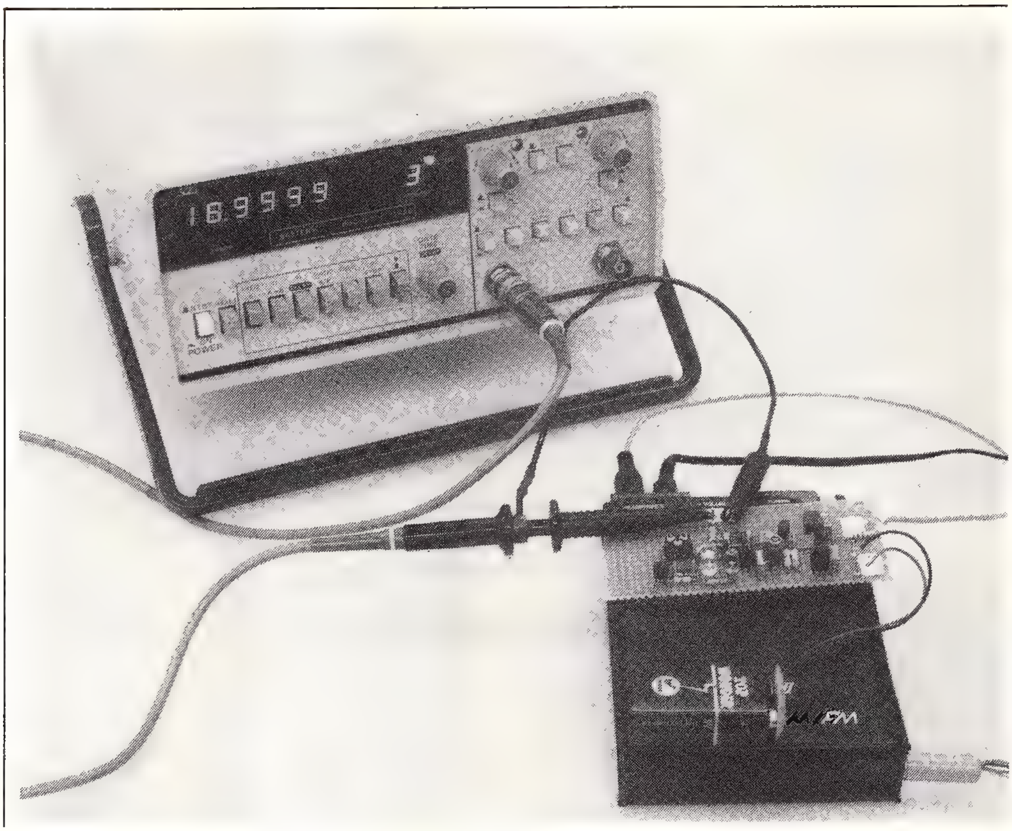
The keyboard may be operated from the Spectrum power supply. It is, however, recommended to use an 8-volt regulator, because a level of 5 V is pretty close to the lower limit of the CMOS ICs. It is further recommended to solder a capacitor of about 220 nF between the supply pins of each IC. The circuit has been working faultlessly in our laboratories for some months, so that we cannot foresee any problems.

Construction

As keytops with the original Sinclair inscriptions do not appear to be commercially available, it is best to use keyboard switches with transparent keytops. These tops snap on to the switch and consist of two parts. The lower part may be engraved, marked with Letraset, or a piece of printed card may be placed on it, so that when the transparent top part is snapped on, the key-top appears to have a printed legend. Character set transparencies are available from many retailers.
The keyboard may be constructed on a printed circuit board (we do not offer one with this project, so it will have to be made by yourself) or on veroboard. Dimensions are about 400 × 150 mm, so unless your retailer stocks this size board, you may have to make one from two. Because of the pressures exerted on a keyboard, mechanical strength of the boards is, of course, vital.

Finally...

...a tip for all d.i.y. programmers. In many games, it is possible to interrupt with the aid of the cursor keys. On the old Spectrum keyboard, the cursor arrows were located above the figures 5...8, and it was, therefore, simple to interrupt the game or other program by writing these figures in conjunction with the INKEY $-function. For instance,
IF INKEY $ = "8" THEN...
Because the cursor keys on the new keyboard are separate, and have no symbol, but only a function character, it is necessary to use the **code** of the cursor function if you want to control the computer with the cursor keys. This can be ascertained from the handbook. The corresponding instruction will now be something like
IF CODE INKEY $ = 10 THEN... ◼



a simple test-instrument calibration aid

19 kHz precision calibrator

Test instruments are essential for any serious laboratory, be it 'professional' or a hobbyist's workshop. Bad test equipment, on the other hand, can be worse than no equipment at all as it gives wrong impressions that are likely to be taken as 'truths'. Accuracy is always a point of doubt with home-made test instruments and for this reason we were very careful to give a detailed test procedure for our recently-published frequency counter. In hindsight, however, it occurred to us that one point could be considered as an example of 'Catch 22': a good frequency counter was needed to calibrate the crystal oscillator. To remove this difficulty we came up with a simple, but accurate, circuit.

A test instrument must be reliable and accurate and, in general, the more you are prepared to pay the more of these two qualities you can expect. Home-made equipment is somewhat of an unknown quantity in this respect and must in some cases be referenced to other proven test instruments. This is the case with the frequency counter circuit, whose crystal oscillator must be calibrated with reference to a frequency meter that is known to be accurate. Fortunately, there is a way out of this 'Catch 22' situation, and all that is needed is the small circuit shown here and a cheap FM transistor radio.

19 kHz from the radio

The frequency of 19 kHz was not simply chosen at random for this circuit. This is, in fact, the frequency of the pilot tone transmitted in FM radio signals. In the case of good quality or hi-fi tuners, however, this frequency is very effectively suppressed after the stereo decoder so they are unsuitable for our purposes.

The loudspeaker or earphone output of a mono FM radio is connected directly to the input of our circuit. Band-pass filter R1/C1/L1/C2 removes all unnecessary parts of the signal and this is then amplified by T1 and fed into pin 3 (INPUT) of IC1.

The 567 (IC1) is a phase locked loop (PLL) used as a tone decoder. The functions of each of its pins are indicated in the diagram of figure 1. The PLL is tuned to a particular frequency by means of the external timing components connected to pins 5 and 6. The values indicated set IC1

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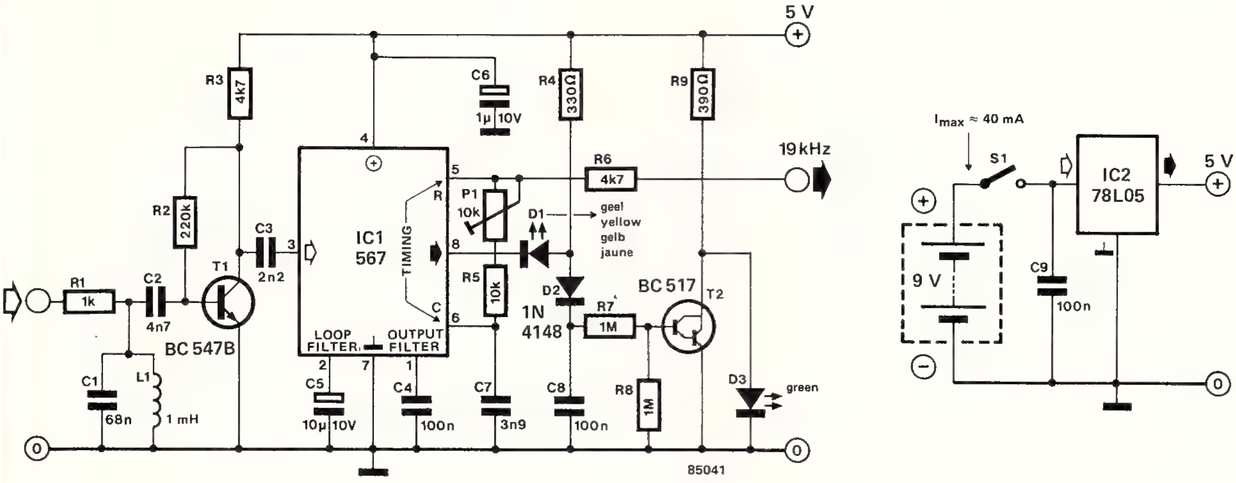


Figure 1. With a cheap radio connected to its input this circuit is a very effective 19 kHz calibrator. Depending on the actual radio used it may be possible to draw the power supply of 9 V d.c. from the radio's batteries or power source. The circuit's current consumption is about 40 mA with both LEDs lit. If the radio cannot supply it the 9 V can be provided by separate batteries.
A different value of inductor can be used for L1 but the capacitance of C1 will then have to be re-calculated from the formula: $C1 = 1/4\pi^2 f^2 L$, where f = 19 kHz, of course.

to a frequency of 19 kHz, of course. The band-width of this 'lock frequency' is determined by C5, while C4 serves to suppress the effects at the output of spurious input signals outside the lock range.

When IC1 detects an input signal within the frequency range selected it locks onto it. The 567's output then goes low so the yellow LED lights. If the PLL is not properly locked onto the input signal, or if the input signal does not remain within the lock range for a while, capacitor C8 is partly charged so the green LED cannot turn on. As soon as the PLL is properly locked onto the 19 kHz signal T2 is turned off and the two LEDs light together. The signal output from pin 5 of IC1 is then a square wave with a frequency of exactly 19 kHz.

Construction, calibration and use

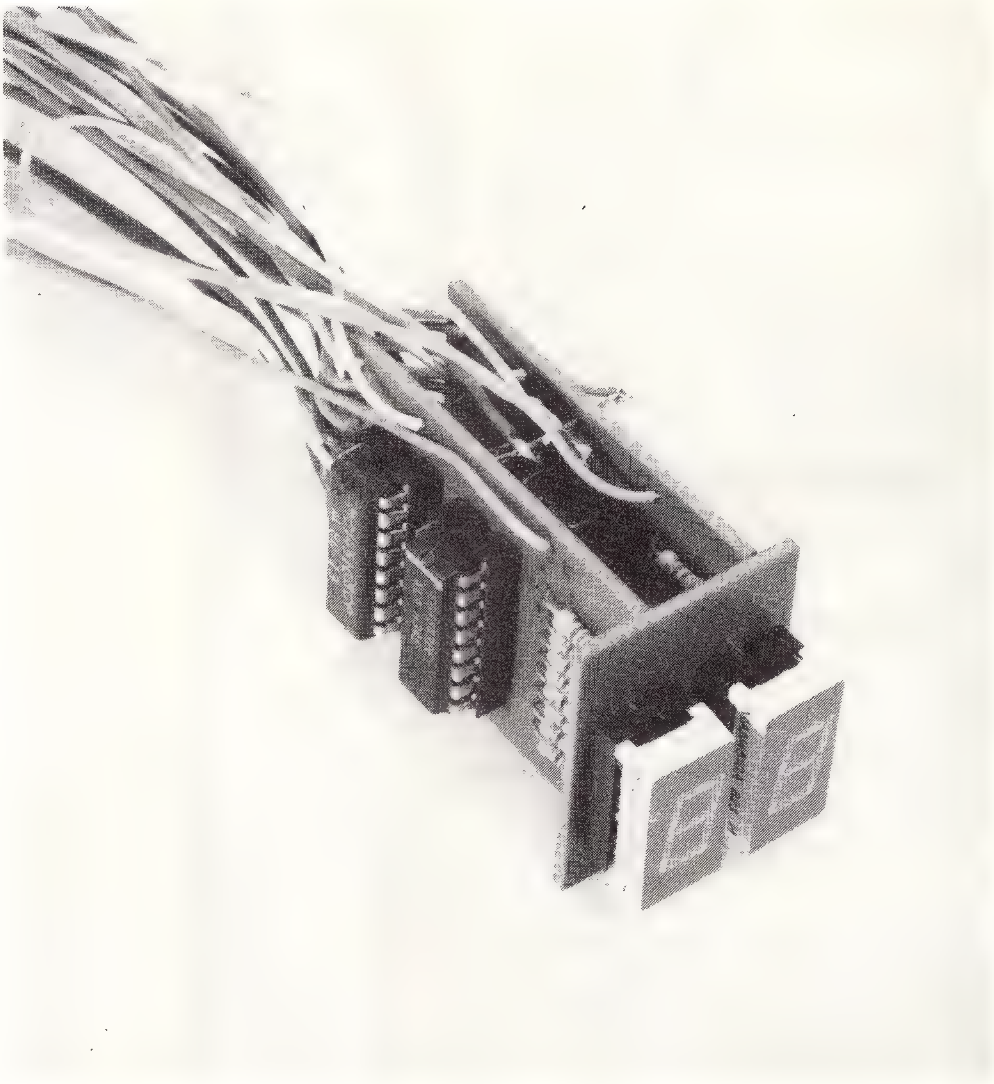
The circuit should be constructed carefully bearing a few points in mind. Keep all wiring as short as possible and make sure to use thick cable for the ground and positive voltage supply lines. It is also very important to connect capacitor C6 as close as possible across IC1's V_{CC} and ground pins (4 and 7).

Connect the input of the circuit to the loudspeaker (or earphone) output of an FM mono radio and tune into a strong transmitter broadcasting in stereo. Carefully set preset P1 so that the green LED just lights at the input signal's minimum amplitude.

To use the circuit increase the radio's volume control slightly and tune into a different transmitter. The yellow LED lights when IC1 locks. The green LED will only light if there is not too much noise on the signal. Increase the volume setting or/and tune to a different transmitter until the green LED lights continuously. If the green LED lights when the radio is tuned to a number of different transmitters the circuit is working correctly and the output signal then has a frequency of 19 kHz.

There are a few final points regarding using this circuit. First of all, it is advisable to tune the radio to a 'quiet' transmitter such as a classical music program. There is less chance of noise or interference on such a signal than would be the case with a contemporary music program. The second point concerns the accuracy of the 19 kHz pilot tone. The EBU (European Broadcasting Union) norm states that this must be 19 kHz ± 2 Hz. This is quite a tight tolerance but in most cases the signal will be even closer to 19 kHz. The measurements we made showed that the signal was, in fact, accurate to within ± 0.001%.

This test circuit was designed as an aid to setting up the microprocessor-controlled frequency counter described in the January 1985 issue of *Elektor* but it can also be used to test and calibrate other laboratory equipment. In the case of the frequency meter simply let it warm up first and then measure the 19 kHz with the A input. Trim the preset in the oscillator until the display shows '19.0000 KHZ'. By the same token this circuit need not only be used for calibration purposes. It could be used in any application where a very accurate 19 kHz signal is required but because a radio has to be connected to its input it cannot be considered as a permanent fixture.



Counter circuits have long been a tradition in Elektor. It started with one of the very first issues way back in 1975 and has continued ever since. In spite of this we still get regular requests for counters to do this and counters to do that. To satisfy all these, we have developed a counter circuit that can:

- **count upwards and downwards;**
- **be used with a variety of displays: LED, LCD, FD, and others;**
- **store the counter contents;**
- **preset the counter position.**

versatile counter circuit

upwards or downwards, for LED or LCD, for common-cathode or common-anode

The circuit diagram in figure 1 shows nothing really surprising: decoder, IC1; counter, IC2; and seven-segment LD1. The surprises are contained within the ICs!
IC2 is a synchronous BCD upwards and downwards counter whose content may be preset. The presetting function is asynchronous.
BCD counter ICs generally contain four bistables and a number of gates with which the required function can be arranged. Asynchronous operation means that one of the bistables toggles when the clock at its input changes. In other words, each bistable is clocked by its predecessor. Operation is synchronous when the output level of a bistable changes when the output level of the preceding bistable goes logic high **and** a fresh clock pulse arrives at its input. This pulse is provided simultaneously to the clock inputs of all the bistables. With this arrangement the result does not have to wait for the clock to be provided to the

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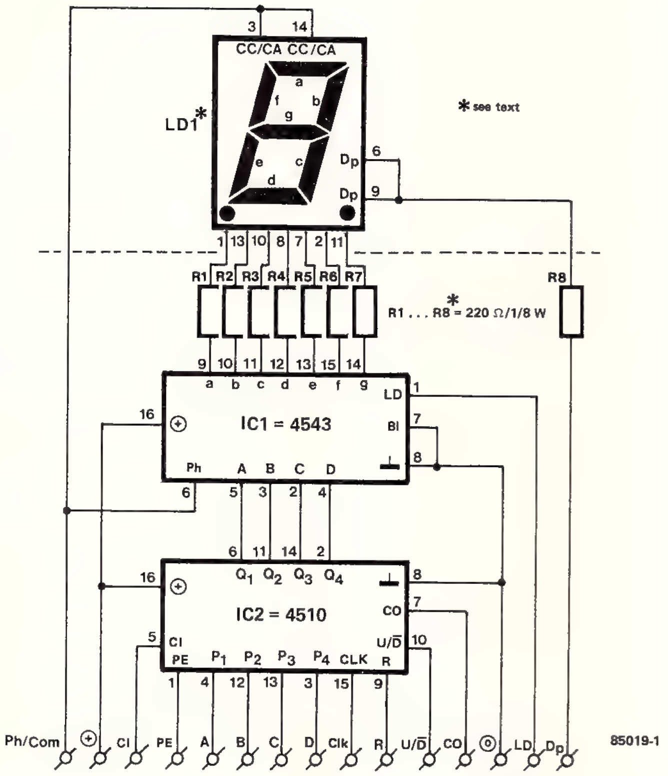

Figure 1. A counter element consists of a counter IC (synchronous BCD upwards and downwards counter with asynchronous preset), a decoder IC (BCD-to-seven-segment decoder with latch and display driver), and the LED display.

last in a long line of bistables.
For instance, in an eight-stage counter operating in the asynchronous mode, 32 bistables have to be clocked before the result is indicated. In synchronous mode, the result is known immediately.
There are therefore seven terminals needed: two for the supply voltage, U_b (3. . .18 V), four for the outputs of the bistables (Q1. . .Q4), and one for the clock input (Clk) which is internally connected in parallel to all bistables. Then there is an input for signal U/$\overline{D}$, which gives the command to count upwards or downwards. And, of course, there is a reset (R) input.
Preselection of the counter position is carried out via inputs P1. . .P4. The lowest value bit accords with P1 (and subsequently with output Q1!). Preselection is evaluated when input PE is logic 1, independent of the clock signal; this mode of operation is therefore asynchronous.
The two remaining terminals of the counter IC are CI (carry in) and CO (carry out). It is these terminals that make the circuit of figure 1 into a proper functional element, for they make the connection between the previous and the following counter elements. The counter elements can thus be connected in cascade by connecting the CO of the previous element to the CI of the next.
The other IC, a BCD-to-seven-segment decoder with latch and display driver, is similar. A glance at the pin-out shows that seven outputs are available for display segments a. . .g. Then it has four inputs for the BCD information, A. . .D, and two terminals for the supply voltage of 3. . .18 V.
The interesting pins here are Ph, Bl, and LD. Pin LD is normally logic high; when it

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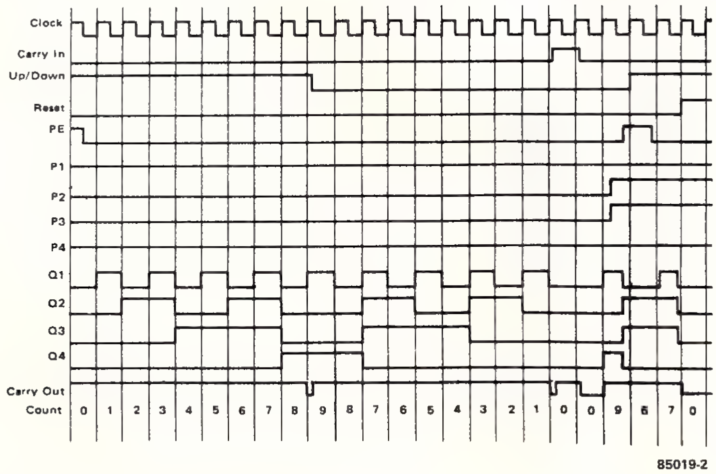

Figure 2. Operation of the counter IC is more easily understood with the aid of this timing diagram.

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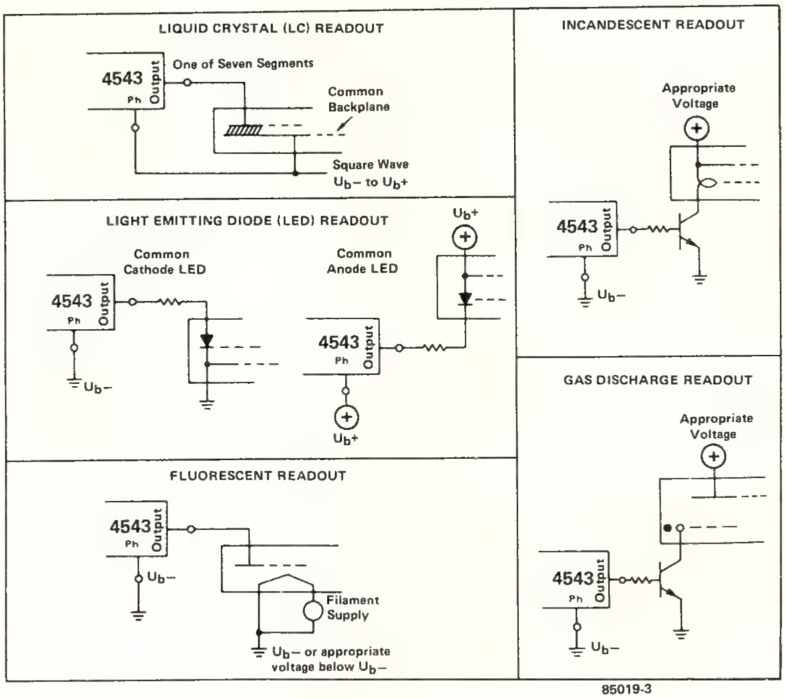

Figure 3. Connections to various display readouts. When a liquid crystal display is used, the decimal point should be connected via an XOR gate: the inputs of the gate to Ph and Dp, and the output to Dp.

Table 1

R = reset
CI = carry input
CO = carry output
PL = parallel load
U/D = up/down
Clk = clock
PE = pulse enable
Dp = decimal point
Ph/Com = common anode/ common cathode
LD = latch disable

Parts list

Resistors:
R1 . . . R8 = 220 Ω/1/8 W

Semiconductors:
LD1 = MAN4410A gr; MAN4610A o; MAN4910A r; MAN4810A y (all General Instrument) for Siemens or Hewlett Packard types see text
IC1 = MC14543B (Motorola)
IC2 = MC14510B (Motorola)
Printed circuit board 85019

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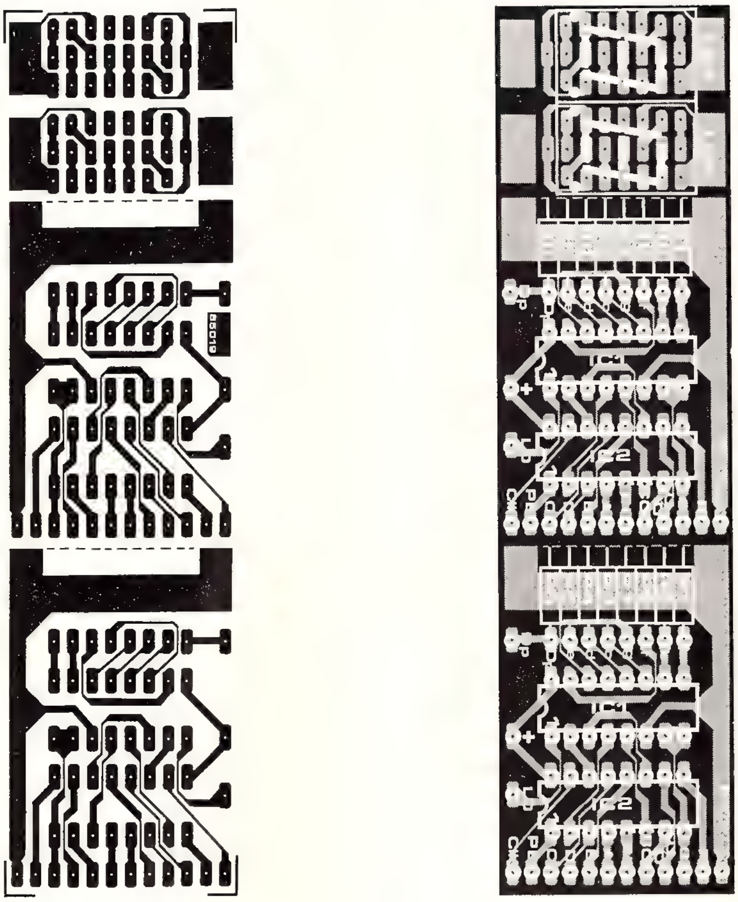

Figure 4. The printed circuit board can house two counter elements; it should be cut into two, with one part containing the display section, or into three if only one element (and display) is required.

goes low, the information at the BCD inputs is stored in the IC, and the memory content is subsequently fed to pins a. . .g. Pin Bl is normally logic low. When it goes high, all pins a. . .g are low. The segment outputs are also logic 0 when a number greater than 9 (in BCD code) is present at the input pins.

The junction of pin Ph is best seen with reference to figure 3, which shows the various connections to the display readouts. We have opted for the LED

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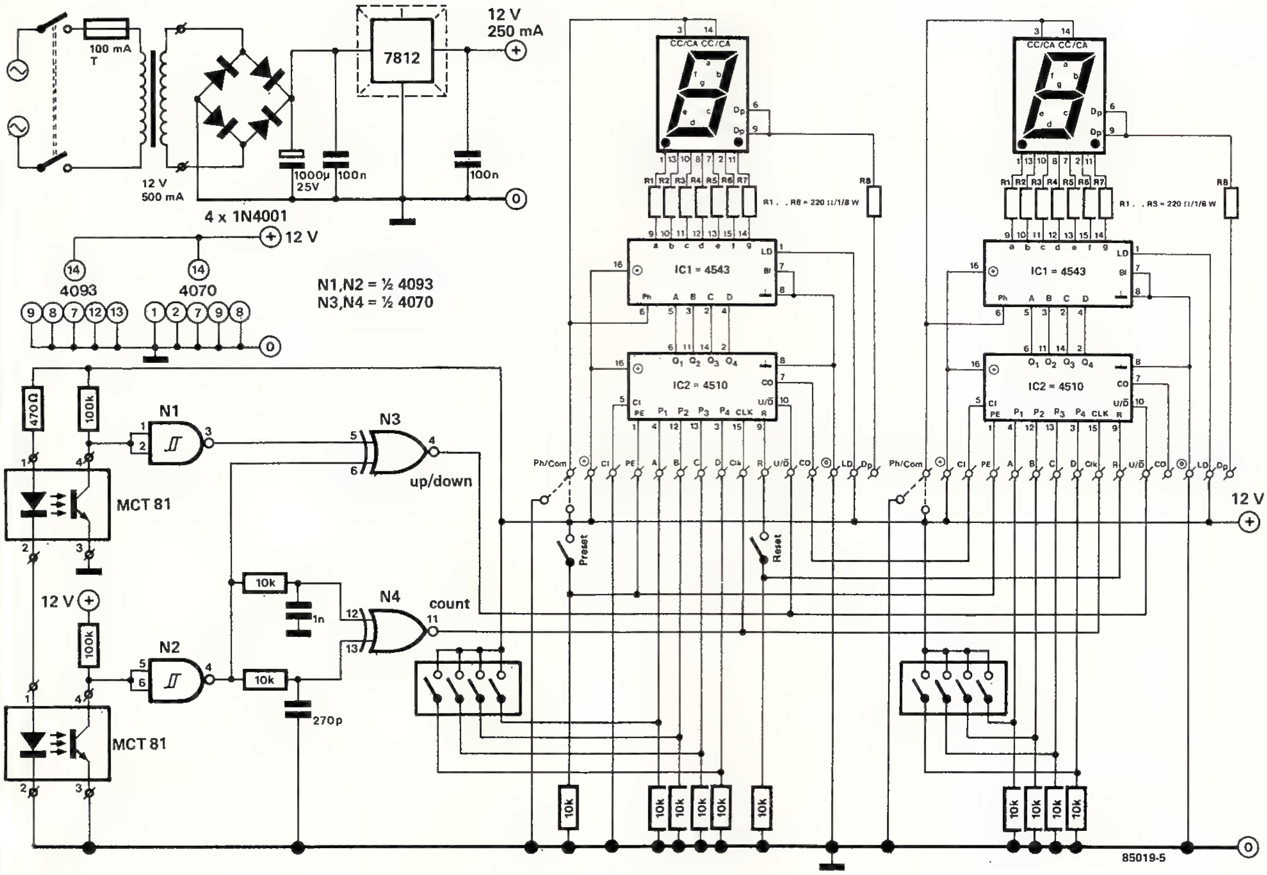

Figure 5. Example of an adaptation of the *revolution counter* described in the September 1981 issue of *Elektor*. Note that only two of the six required counter elements are shown.

display, because this is not only the most economical but is also the most suitable for use with this particular IC.

Construction

A printed circuit for two counter elements is shown in figure 4. The board should be cut into two, with one part containing the display, or into three if only one element (and the display) is required.

The boards are put together as shown in the photograph: that containing IC1 and IC2 is at right angles to the display board. The earth planes of the boards must be soldered together; this makes it imperative that the boards are cut absolutely straight. Additional stability is provided by resistors R1...R8 being soldered to two boards!

Most terminals are located at the short edge of the board(s); only Dp, +, and LD are at the long side. This was arranged so that when several boards are in cascade, they can be placed side by side on a prototyping (vero) board. To ensure sufficient stability, the terminals at the long side, and possibly also the Clk terminal, must be soldered to the vero board. Our prototype which was assembled in this manner proved more than adequately stable. Do not forget to connect the CO terminal on one board to the CI terminal on the next.

A final word about the LED display. Since IC1 can provide a segment current of only 10 mA, it is advisable to use the General Instrument type given in the parts list. Siemens and Hewlett Packard types draw rather more current, about 15..25 mA, for the same light intensity. When these types are used, it is therefore advisable to buffer each of the segment outputs as, for instance, in figure 3 (incandescent or gas discharge readout).

Take care to solder the Ph/Com terminal with correct polarity.

Applications

One of many possible applications of the counter element is shown in figure 5, which is an adaptation of the *'revolution counter'* described in the September 1981 issue of *Elektor*. As is shown, the special IC type MK50398 then used is replaced by six of the present counter elements (of which only two are shown in figure 5).

As we said in the beginning, there is no counter requirement that cannot be solved by the element presented here! ◼

darkness-sensitive light
switch
elektor march 1985

As can be read almost daily in any newspaper, the number of burglaries in private residences continues to increase. The police are overworked, and the courts, as usual when it concerns crimes againts the private citizen, far too lenient, so that manufacturers of security equipment are, understandably, doing good business in spite of the hefty prices they charge for their products. The philosophy appears to be that if you have something worth protecting, you're normally quite prepared to pay for it. But does it really have to be so expensive? Since it is a fact that most burglaries occur during the hours of darkness, we feel that even a relatively simple, and inexpensive, switch as suggested here will deter most would-be intruders. And don't forget, no security system, however expensive, gives one hundred per cent protection!

darkness-sensitive light switch

to frighten off would-be burglars

The great advantage of the proposed electronic switch, compared with its mechanical counterpart, is that it is fully automatic in operation. When it gets dark around your house, the lights at the front and back doors are automatically switched on and turned off again at daybreak. The degree of darkness or light at which this happens can be preset. The darkness-sensitive switch is based on a light-dependent resistor (LDR).

The circuit diagram of the complete electronic switch is given in figure 1, from which it will be noted that the number of components has been kept to an absolute minimum. This was made possible by the use of a mains-synchronized trigger IC for silicon-controlled rectifiers, the type TDA 1024. This can conveniently be fed from the mains via a simple series RC network, R4/C2, so that a separate supply is not necessary. Capacitor C3 also serves as a current-limiting component, while resistor R3 limits the current caused by the closing of mechanical switch S1 and by high-frequency mains noise.

Basically, the electronic switch proper is triac Tri1. Every time the mains passes through zero, the triac is fed by a trigger pulse from IC1, but only when it is dark outside. Triggering at the zero crossing point has the advantage that high-frequency noise generated at the on or off switching of the load is kept very low. If the triac were triggered at any arbitrary moment, sharp pulses of current, which are rich in hamonics, might contaminate the mains supply. Another advantage of switching at the zero crossing point is that the initial current through the cold lightbulb(s) is limited which increases the useful life of the bulb appreciably (see also '*lamp saver*' in the September 1984 issue of *Elektor*).

The trigger pulses generated by the TDA 1024 are very short. A constant gate current would cause too much heat generation in the IC itself and in resistors R3 and R4, that is, the components that draw the required trigger energy from the mains. Resistor R3 largely determines the pulse duration and, together with the on-chip zero crossing detector, ensures correct synchronization of the pulses with the mains. The value of this resistor is calculated so that at the end of the trigger pulse the momentary current through the load, that is, light bulb La, is definitely greater than the holding current of the triac. If that were not the case, the triac would turn off immediately the gate pulse decays, and, if a bulb of low power were used, this would either not light at all or, at best, flicker. The latter of the two effects is caused by the asymmetry in holding currents and occurs when the momentary load current after the decaying of the pulse is larger than only one of the two holding currents. This is the reason that the diagram in figure 1 does not only

Figure 1. The circuit diagram of the darkness-sensitive light switch which automatically turns the outside light(s) on and off depending on the ambient outside light. The sensor used is an LDR (R8). The integrated mains-synchronized trigger circuit type TDA 1024 enables the practical realization of the switch to be small. One of the advantages of mains-synchronized triggering is an appreciable increase in the life of the light bulbs used.

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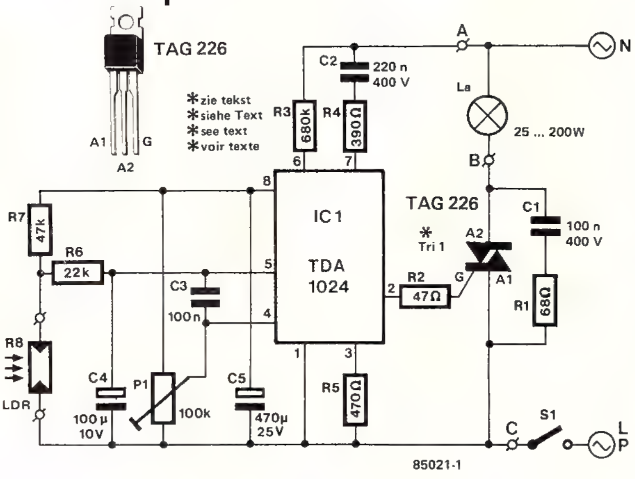

state a maximum, but also a minimum power rating for the lightbulb(s). If a triac type TAG 226 is used, of which the positive (from A2 to A1) as well as the negative (from A1 to A2) holding current is 10 mA at 25°C maximum, the circuit will function correctly even at temperatures round freezing point and bulb ratings of 25 W. Higher bulb ratings (up to 200 W) or a more sensitive triac allow even lower temperatures, which is important if the electronics are placed outside; we will come back to this later in the article.

Network R1/C1 in parallel with the triac has the task of preventing the triac to commence conducting on high-frequency noise pulses generated by other appliances.

When a light-dependent resistor, such as R8 in figure 1, absorbs light, its resistance decreases. The LDR is here connected in a Wheatstone bridge, one arm of which is formed by resistor R7 and the LDR, and the other by preset P1. The preset enables the bridge being set so that the light bulb is turned on when it gets dark outside. The voltage balance across the bridge is determined by a comparator in IC1 (pins 4 and 5). Network C4/R6 delays the bridge being unbalanced by flashes of lighting or ohter short changes in light intensity. Capacitor C3 decouples the comparator input. Capacitor C5 smoothes the control voltage generated by the IC.

To prevent erratic operation of the circuit during slow changes in outside light, as at dawn or dusk, the IC has inherent switching hysteresis, which may be fixed externally between two limits by R5. The hysteresis varies between 10 and 300 mV for values of R5 between ∞ and zero; a practical average value has been chosen in the present circuit.

Practical aspects

Due to the use of an integrated trigger circuit, the printed circuit board of the light switch could be kept small enough (65 × 50 mm) to fit in a single junction box. This may, of course, be one that is already part of your electrical system, provided this is on the circuit (i.e. same fuse) to which your outside light is, or will be, connected and that there is space for the board.

In the following it is assumed that you have to fit outside lights. From a convenient take-off point in the electrical system, run 5/8 in. conduit to the position where the junction box with PCB will be located. Also fit a mains on/off switch (S1 in figure 1) near the box or in any other convenient position in the new run. The junction box should preferable be fitted indoors, because low temperatures make the triac less sensitive and it is less likely to be damaged by intruders.

If, however, you have no choice but to place it outside, use a more sensitive triac, such as the TAG 206 or TAG 207, light bulbs of not less than 40 W, and fit the box out of easy reach.

From the junction box run a 3-core cable to the outside light(s) and a 2-core cable to the sensor (LDR) as shown in figure 4. These cables should be run in conduit or

Parts list

Resistors:

R1 = 68 Ω
R2 = 47 Ω
R3 = 680 k
R4 = 390 Ω
R5 = 470 Ω
R6 = 22 k
R7 = 47 k
R8 = light-dependent resistor, 50 . . . 100 k
P1 = preset 100 k

Capacitors:

C1 = 100 n/400 V
C2 = 220 n/400 V
C3 = 100 n
C4 = 100 μ/10 V
C5 = 470 μ/25 V

Semiconductors:

IC1 = TDA 1024
Tri1 = triac, min. 4 A/400 V; max. holding current ± 10 mA; max. positive trigger current 10 mA; suggested types TAG 226 or TAG 227 — more sensitive types are TAG 206 or TAG 207

Miscellaneous:

2-way terminal block for PCB fitting
3-way terminal block for PCB fitting
PCB 85021

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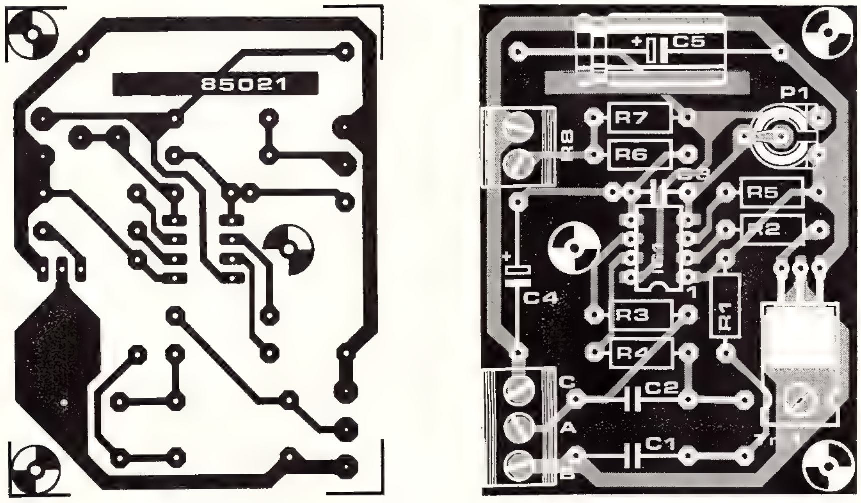

Figure 2. The printed circuit of the light switch is easily fitted inside a single junction box. The triacs suggested need not be cooled with bulb ratings up to 200 W. Higher ratings are not recommended, even with cooling of the triac: heat dissipation in a watertight junction box is not very good.

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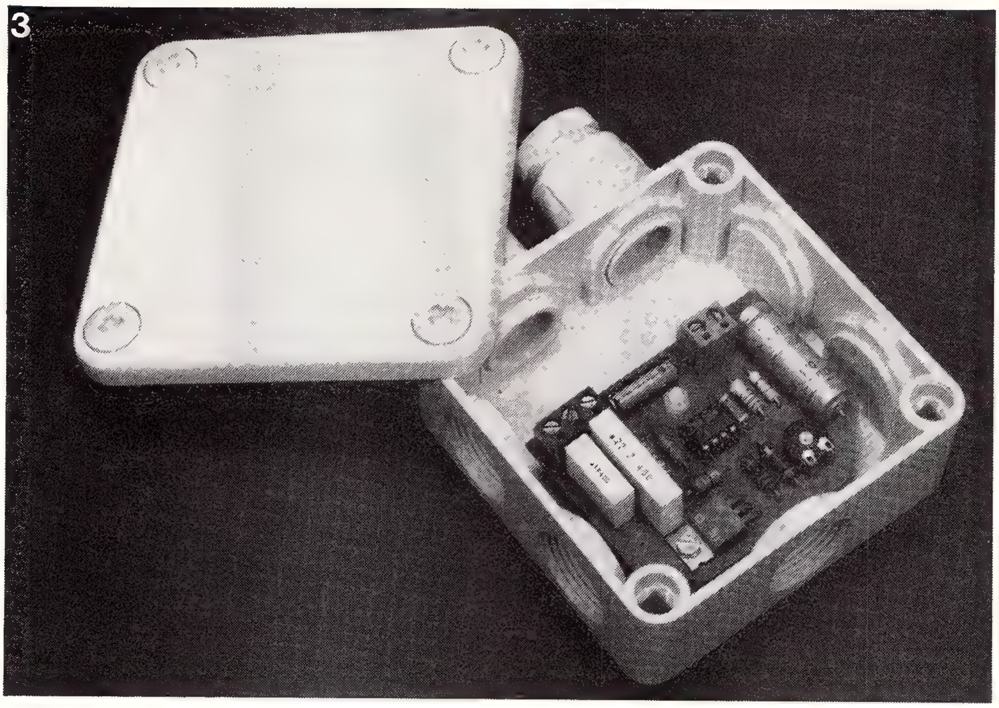

Figure 3. Photograph showing the light switch fitted in a junction box.

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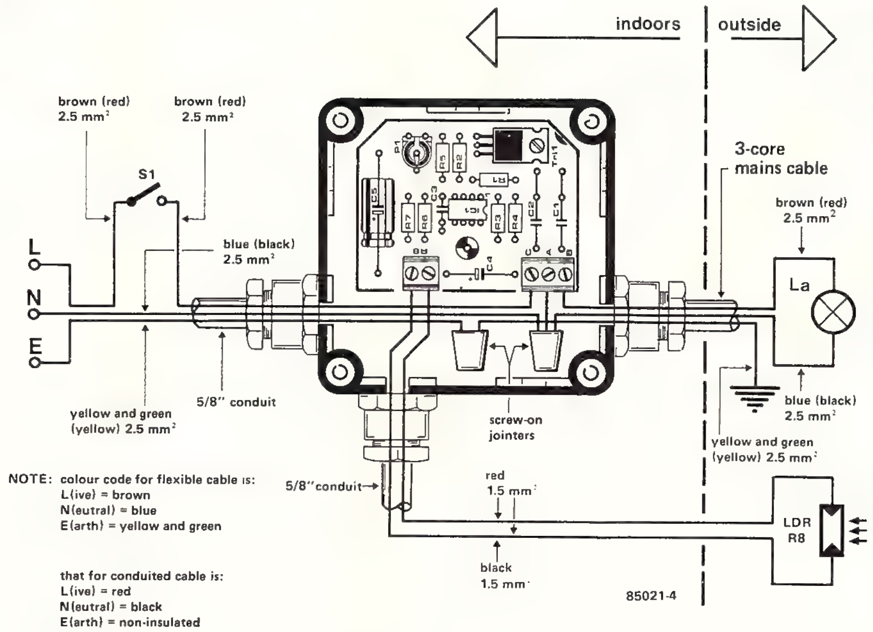


Figure 4. Suggested installation diagram. The colours in brackets refer to obsolete wire colour codes.

be suitable, preferably armoured, for outdoor use. The green and yellow wire shown near the bulb La is intended for earthing the metal parts of the lampholder.

The most convenient way of fitting the sensor is to cut the conduit containing the 2-core cable flush with the outside wall, connect the cable to the LDR, and then fix the resistor to the conduit with araldite (make sure that this is transparent!). Needless to say, there are various other ways of fixing the resistor, but it is, of course, important that whatever you choose ensures watertightness.

Only incandescent light bulbs with a total rating of not more than 200 W should be used. Neon or similar tubes should not be used because their inductive properties would upset the triggering of the triac.

Rest the calibration of the light switch. Wait till you find it's dark enough outside and then, using an **insulated** screwdriver (called a mains tester or electricians' screwdriver), adjust preset P1 so that the light just comes on. That's all!

Remember to keep switch S1 turned on; this switch is not superfluous, however, because it should be possible to remove the mains from the circuit.

If you already have outside light(s), simply fit the electronic light switch between the existing mechanical switch and the light(s). The sensor should, of course, still be fitted as described above.

Obviously, you cannot expect automatic outside lights to be a guarantee against intruders. But, coupled with security locks on outside doors and windows, they offer good additional, yet inexpensive, protection measures against would-be intruders.

As the title implies, this project is not intended to make hi-fi buffs sit up, but rather to meet the many requests for a simple active loudspeaker that can be connected direct to the headphone output of small cassette players and FM receivers.

mini active loudspeaker

good sound reproduction at low cost

The main requirements our designers were asked to meet were: reasonably small dimensions, not too expensive to build, active operation, and good quality sound reproduction. Furthermore, it had to be a loudspeaker system that could be constructed by anyone, which also meant that the integral amplifier had to be kept simple. The result is a perfectly acceptable concept which leaves room for some variation, dependig on personal preferences and available materials.
Purely from a quality point of view, an enclosure of about 7 ×4$^{5}/_{8}$ × 3$^{1}/_{8}$ in. (18 × 12 × 8 cm) cannot be claimed to have more than a modest specification and yet it is surprising how well this small unit behaves, particularly if it is fitted with the recommended two-way system.

Loudspeakers

The choice of loudspeaker unit(s) is, of course, of paramount importance. Fortunately, there are quite a number of suitable loudspeakers on the market. Those we tested varied in quality from reasonably good to excellent.
Of the loudspeaker units we tested for a one-way system we found the 8-cm Visaton type FRS8 and the Audax type HIF78BiSM best value for money. In the final analysis the Audex wins on points because it has slightly better bass response and power handling (15 W compared with the 10 W of the FRS8). Of the 10-cm types, the Isophone BPSL100/7 (10 W) and the Audax HD10P19BSM (15 W) gave the best results. One-way systems using these loudspeakers are eminently suitable for use in bedrooms, hobby-rooms, and teenagers' bedsitters.
Our own preference, however, is a two-way system that uses two Audax speakers which fit nicely in the proposed enclosure. The woofer is a type HD10P25FSC (which can also be used as a single unit in a one-way system) and the tweeter a type TW60A (which is also available in different constructions and then type-coded TW51A, TW74A, or TW80A).
The HD10P25FSC has a resonance frequency of 52 Hz and power handling of 30 W. It has reasonable mid-frequency performance which starts tapering off at about 5...6 kHz. As the TWA60A's range goes down to well below those frequencies, these two speakers, together with a simple crossover network, form a perfect combination for our purposes. The TW60A has a power handling of 40 W and measures 6 ×6 cm.

Electronics

The electronic part of the system is kept quite simple as shown in figure 1, and consists of a power supply, an integrated 15 W power amplifier, and a passive crossover network.
The power supply could not be simpler: a transformer, a bridge rectifier, and two electrolytic capacitors — that's all.
The power amplifier is just as simple, consisting of just an amplifier module type HY-30 and a volume control, P1. Even the heat-sink is integral with the IC! The HY-30 has only five pins so that mistakes in connecting up are virtually impossible. The volume control will in many cases not be required, because the output level of most cassette players or FM receivers is already adjustable.
The crossover network, R1-R2-C3-C4-L1, has a slope of 6 dB/octave which is not particularly steep, but that is not required with these loudspeakers anyway. It has, however, the advantages over higher-order

1

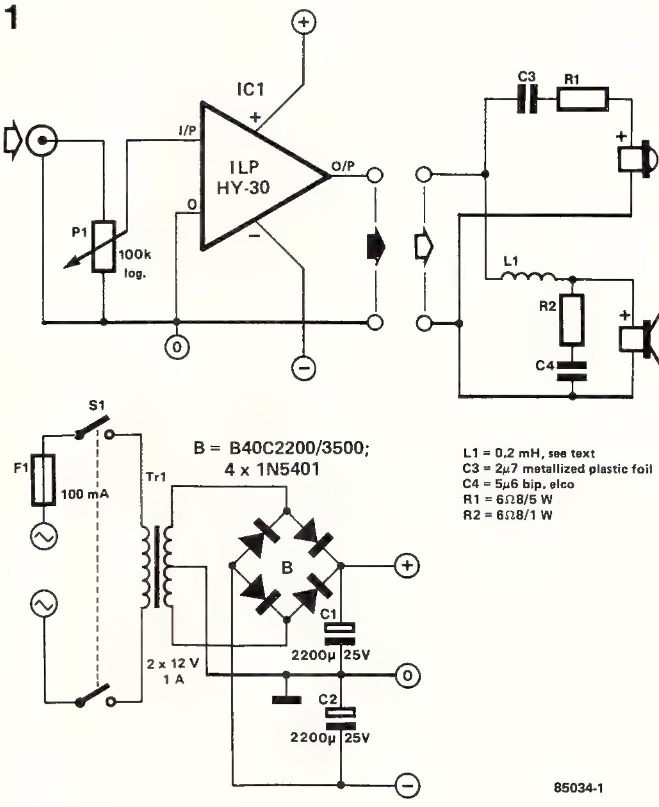


Figure 1. The complete electronics of the mini active loudspeaker unit: a simple power supply; an amplifier module; and a passive crossover filter for the two-way system.

2

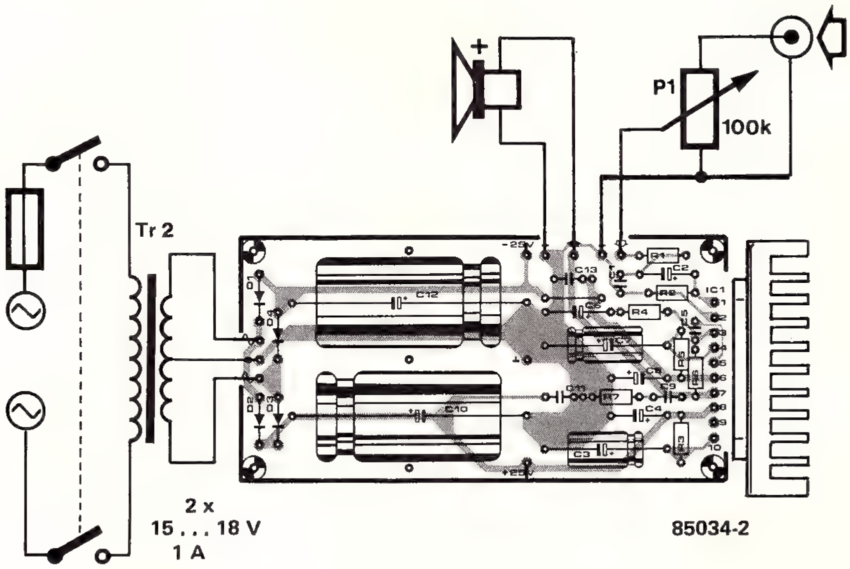


Figure 2. The 30 W a.f. output stage published in the January 1985 issue of *Elektor* is a suitable alternative to the HY-30 IC shown in figure 1.

networks that the phase shift it introduces is very small and its response to pulses is better.

Note that L1 is not a miniature choke, but a coil specially made of 0.75...1 mm dia. wire for crossover networks.

Alternative power amplifiers

It is, of course, possible to use a power amplifier other than the HY-30 IC. In fact, any reasonably good 15...20 W amplifier may be used, provided it fits in the box. A suitable alternative is the 30 W a.f. output stage published in the January 1985 issue of *Elektor*. That amplifier provides 20 W into 8 ohms and has the advantage that, together with the required power supply, it may be cronstructed on our 85001 pcb. A schematic of the ensuing layout is given in figure 2.

Enclosure

The main requirements for the enclosure are that it must be fairly robust, relatively free of resonances, and as small as the chosen loudspeakers and the electronic part allow. Our prototype was constructed in a cast aluminium alloy box of 18 × 12 ×8 cm which is available from many retailers. Because of its high rigidity, cast aluminium alloy is eminently suitable material for a loudspeaker enclosure. Although the sides of the box are not particularly thick, there is virtually no tendency to resonate. Normal damping is achieved by covering the side and rear panels internally with one-inch thick glass wool or rock wool.

Construction

Most of the constructional details will be clear from figure 3. The power transformer is suspended from the top panel; the electrolytics and bridge rectifier are fitted to the rear panel. Cut a rectangular hole of 55 × 40 mm centrally in the rear panel underneath the rectifier, to which the HY-30 module is fitted. The sides of this module have special slots into which the fixing bolts fit. Any gaps between the module and the enclosure should be sealed with two-component epoxy resin. The crossover filter is mounted at the bottom of the box. Mains input (with strain relief sleeve), fuse holder, signal input socket, and, where appropriate, the volume control are fitted in the left-hand side panel.

The loudspeakers are mounted inside the lid of the enclosure. The woofer requires a circular cut-out of 92 mm diameter and the tweeter one of 50 mm diameter. Take care to connect the speakers with correct polarity: the + is indicated by a red dot near the relevant speaker terminal.

Once the unit has been wired up and tested — there is no calibration — the strips of glass wool or rock wool should be pressed against the side and rear walls. For the sake of clarity, these strips are not shown in figure 3. Finally, fit a pressure sensitive adhesive sealing strip at the inside outer edges of the lid, which can then be screwed into place.

Finally, figure 4 shows what the enclosure inside looks like when the alternative 30 W a.f. output stage is used instead of the HY-30 module. This set-up requires rather more space, so that you may have problems if you opt for the two-way speaker system and your mains transformer is on the large side. However, if you use a single speaker, there should be no problem as is clear from figure 4. Note another advantage of using a metal enclosure: there is no heat sink required for the power output IC!

3

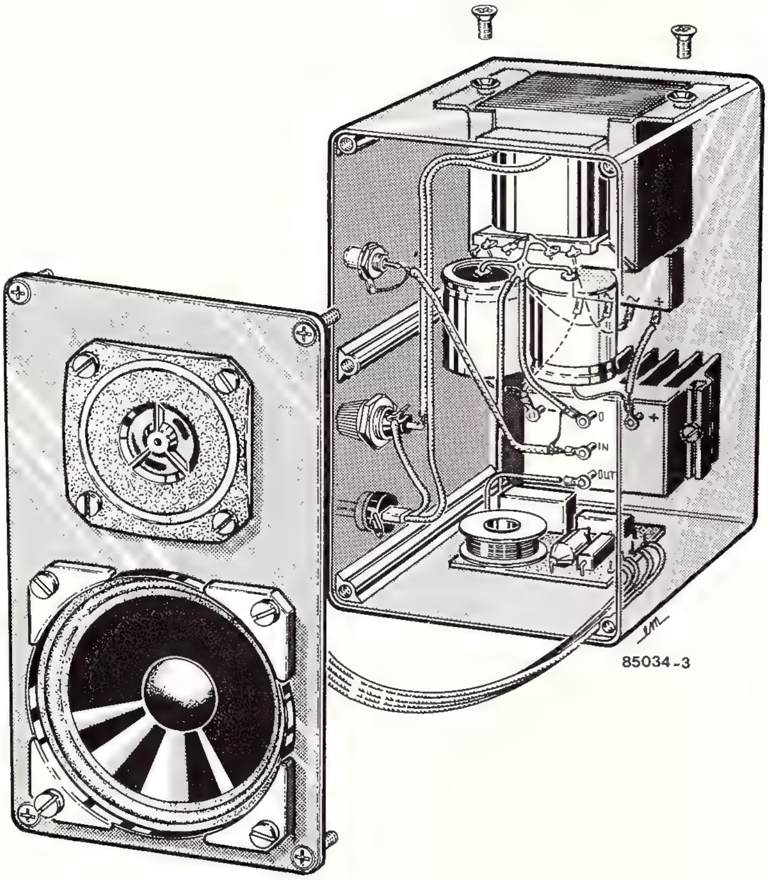


Figure 3. Loudspeakers, crossover network, amplifier module, and mains power supply fit neatly in a commercially available cast aluminium alloy enclosure. Some strips of glass wool or rock wool (not shown) provide the required damping.

Parts list

Tr1 = mains transformer, 2 × 12 V/1 A
B = rectifier B40C2200/500 or 4 off 1N5401
C1,C2 = 2200 μF/25 V
F1 = fuse 100 mA (T)
S1 = DPDT mains switch

Amplifier:
IC1 = ILP module type HY-30
P1 = 100 k log potentiometer

Crossover network:
L1 = 0.2 mH (wire dia. 1 mm)
C3 = 2μ7, metallized plastic foil
C4 = 5μ6, non-polarized electrolytic
R1 = 6Ω8/5 W
R2 = 6Ω8/5 W

Loudspeakers:
woofer: Audax HD10P25FSC (8 Ω)
tweeter: Audax TW60A (8 Ω)

Miscellaneous:
cast aluminium alloy enclosure, about 18 × 12 × 8 cm
fuse holder
strain relief sleeve or bush for mains lead
25 mm thick glass wool or rock wool as required
phone socket or jack socket for chassis mounting

4

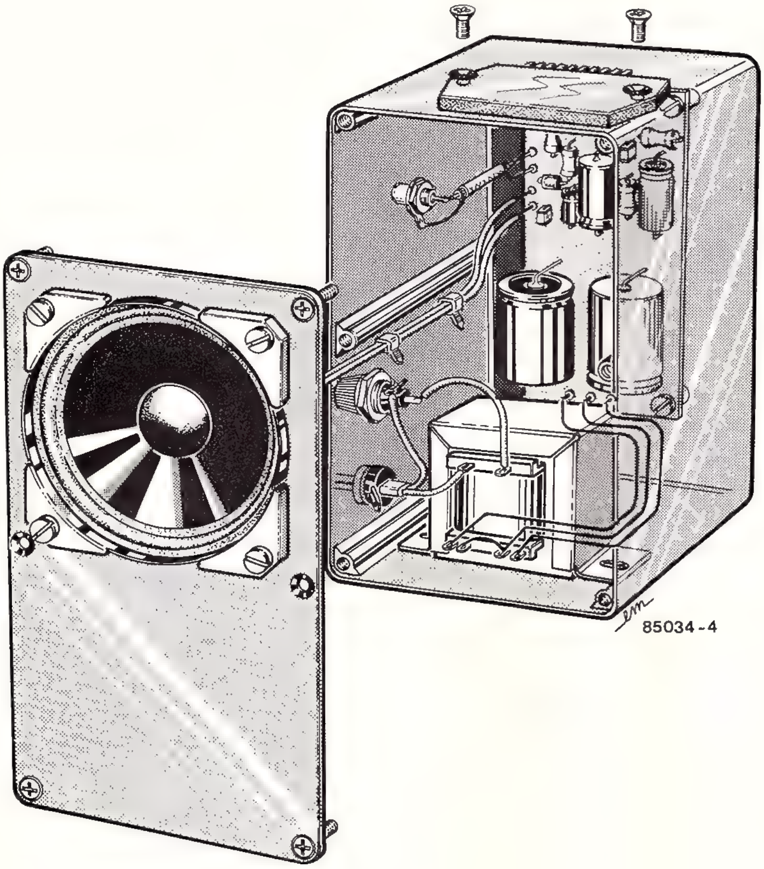


Figure 4. The same enclosure as shown in figure 3 but here fitted with the 30 W a.f. output stage shown in figure 2. The aluminium box is an excellent heat sink for the amplifier IC.

transistor unitester
elektor march 1985

Many electronic components may only be fitted into a circuit in one way: the polarity must be correct in other words. Diodes, electrolytic capacitors, ICs (to name but a few) are marked to show what is their correct polarity but transistors do not have any such indication. Knowing the type of the transistor in question it is, of course, a simple matter to look at the data sheet and find out which pins correspond to emitter, collector and base. If you do not have the data sheet to hand, however, this makes matters somewhat more difficult.

transistor unitester

a universal all-in-one transistor connection tester

G. Fossan

Two things are of vital importance when a transistor is to be used in a circuit, namely which pins correspond to emitter, collector and base and whether it is an NPN or PNP transistor. The transistor's data sheet gives this information but the chances are that you will not have the appropriate data sheet when you need it. A collection of data sheets would seem to be the answer but a much better solution is to make a transistor connection tester like the one shown here.

A switching transistor

The most striking thing about the unitester circuit shown in figure 1 is its simplicity. The component under test, T_T, is used as a switching transistor. The base current is varied with P1 until the transistor switches on and causes two of the LEDs to light. Which LEDs light (D1/D2 or D3/D4) depends on whether T_T is NPN or PNP. (This is defined by the position of S1.) The intensity of the LEDs at a particular position of P1 gives an indication of the transistor's current gain.

The test procedure

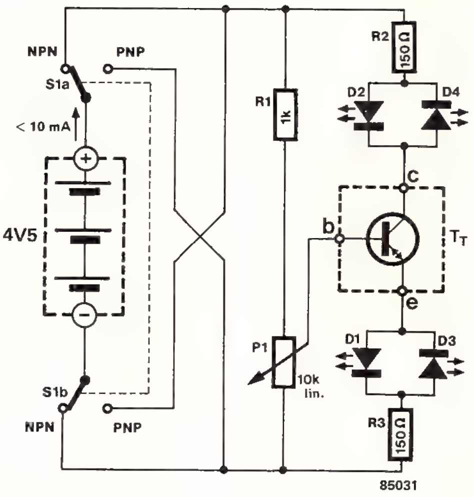
In our prototype we fed the 'b', 'c' and 'e' terminals from the circuit to an IC socket, as the diagram indicates. We found that this simplified using the circuit as all possible connection orders are catered for. To try a different bce layout the transistor's pins are each moved one hole further. A transistor is tested as follows:

- Plug the pins of T_T into the IC socket in any order but making sure that each fits into a different hole — one into 'b', one into 'c' and one into 'e'. Turn P1 completely around and back, then switch S1 over. If one of these two operations causes two of the LEDs to light simultaneously the pin stuck into the 'b' position is the transistor's base. In this case both LEDs will light when P1 is at one end of its travel and both will be off at the other end of the travel. Any other indication on the LEDs indicates an incorrect connection so T_T's pins should be changed around until the right indication is found. If none of the possible combinations gives the correct indication either the transistor is faulty or the component in question is not a transistor.
- Having found the base, the emitter and collector must now be determined. The base current is set with the potentiometer so that moving P1 slightly gives a clearly visible change in the light intensity of the LEDs. The LEDs are set to 'medium' brightness and the collector and emitter connections are then swapped. If the LEDs burn more brightly than before the 'c' and 'e' connections are now correct. If, on the other hand, the LEDs become dimmer the previous arrangement was correct.

Final points

The circuit is easily constructed on a piece of Veroboard and can be connected to a suitable d.c. power source (batteries will be sufficient). The voltage supply should be about 4.5 V, but must never be greater than 6 V. There is no actual need to use an IC socket for the 'b', 'c' and 'e' connections but this does simplify matters. The operation of the unitester can be verified by taking a transistor whose connections are known. Select PNP or NPN as appropriate and plug the transistor correctly into the T_T socket. When P1 is moved fully around two of the LEDs will light or go out, depending on whether they were on or off.

1



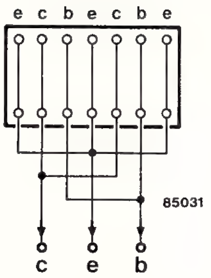
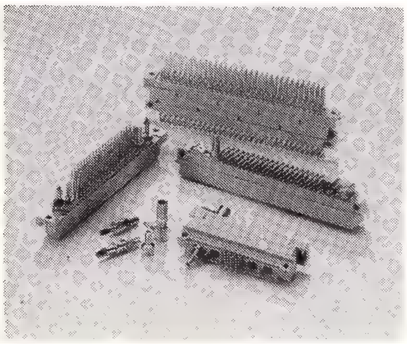


Figure 1. The transistor to be tested is fitted to the 'T_T' position. Its polarity (b, c and e), correct operation and gender (PNP or NPN) are determined with P1 and S1.

Mixed-contact din connectors

A new range of mixed-contact DIN connectors is now in stock at Dage (GB) Limited. Made by Siemens, these connectors offer mixes of standard pins with up to eight cavities for either r.f. or high-power contacts; for instance, to take power on to back panels.

The r.f. contacts are available either for cable-end or for pcb mounting. For power connection, there is a choice from 10 A, 20 A, or 40 A ratings.



Standard commercial DIN connectors, also made by Siemens, are also stocked.

The ordinary DIN contacts are electrolytic gold over nickel. The single-row types B, C, and M have a contact current rating of 1.5 A and contact resistance of not more than 20 milliohms. Types D, F, and G have a contact current rating of 5.5 A and contact resistance of not more than 15 milliohms.

Dage (GB) Limited
Eurosem Division
Rabans Lane
Aylesbury
Bucks HP19 3RG
(0296) 33200
telex: 83518 (3161M)

Yearbook of West European Electronics Data
12th edition

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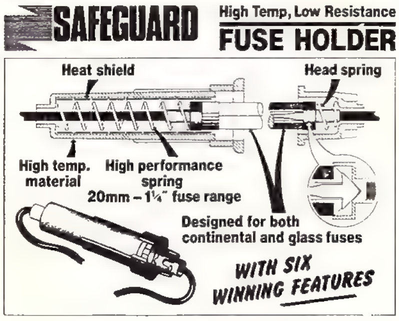
The Customer Response Centre
Texas Instruments Limited
Manton Lane
Bedford MK 41 7PA
(0234) 67466 (3156M)

Revolutionary new in-line fuse holder

A recently announced new fuse holder incorporates several innovations that make it more versatile, economical, and safer than currently available units. For instance, the Safeguard fuse holder has a unique heat reflecting shield to improve the fusing factor. Under overload conditions, heat is reflected back onto the fuse, causing it to fail sooner, thereby improving its safety performance.



The new unit will accommodate a range of fuse lenghts from 20 to 32 mm and will also handle quarter inch caps or continental points.

Safeguard Fuse Company Ltd
63 Woodham Lane
New Haw
Weybridge
Surrey KT15 3ND
(0932) 45300 (3162M)

Macintosh Buyers Guide

More than 200 software, peripheral, and add-on products are contained in this new publication launched by Apple Computer (UK) Ltd. Representing the universe of Macintosh software and hardware, the new guide is available from all Apple authorized dealers in the UK at a maximum suggested retail price of £5.95.

Apple Computer (UK) Ltd
Eastman Way
Hemel Hempstead
Herts HP2 7HQ
(0442) 60244
telex: 825834 (3158M)

Hotmelt glue gun

The Hotfix 180 hotmelt glue gun developed by Power Adhesives Ltd has been selected by the Design Centre. The gun which incorporates the latest technology is designed around a solid-state self-regulating heater. The heater, called PTC (positive temperature control) ensures that the gun reaches proper operating temperatures in 3. . .4 minutes and that it can operate on any voltage between 100 and 240 V. Another advantage of the heater is that no thermostat is required because it regulates itself internally to the correct temperature, ensuring complete accuracy and reliability. The gun takes standard 12 mm diameter Flofix glue sticks.

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103 Wantz Road
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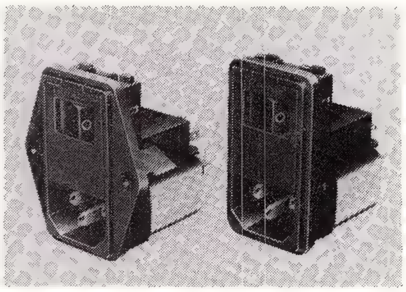
Subminiature trimmer potentiometers

A complete designer's guide to the wide range of newly-developed trimmer potentiometers from Murata is now available in a 24-page manual.

Murata Erie Electronics UK Ltd
100-102 Albert Street
Fleet
Hants
(02514) 28585 (3157M)

New mains filters

A new range of mains filters, the FN380 series, is now available from Schaffner EMC Ltd. Developed for use in electrical and electronic equipment, the FN380 incorporates a power on/off switch and fuse, and is suitable for a wide range of applications, including office machines, electronics instruments, and most types of industrial and professional electronic equipment.



The FN380, which can be supplied with fuse holders for US (6.3 × 32 mm) or IEC (5 × 20 mm) fuses and either a single or a two-pole rocker switch, has been approved to the relevant VDE, UL, and SEV standards, with CSA pending. The filters are available in line current ratings of between 2 A and 6 A at 250 VAC (50. . .400 Hz) and operate over the temperature range −25°C. . .+85°C. Overall dimensions are 58 × 32 ×56.5 mm.

Schaffner EMC Ltd
One Ashville Way
Molly Millar's Lane
Wokingham
Berks RG11 2PL
(0734) 784669 (3163M)

market

You ain't heard nothing yet!

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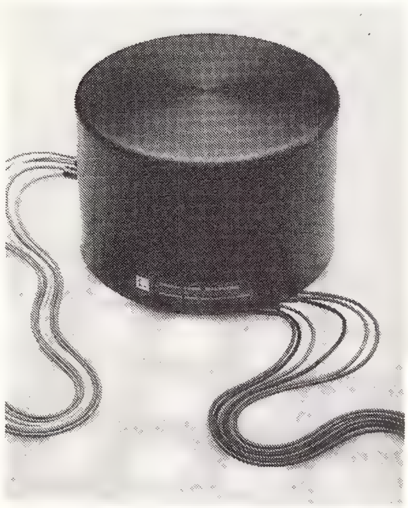

Toroidal transformers are generally half the weight and volume of equivalent stacked lamination types and in the 1200 VA rating competitive in price.

Avel-Lindberg Limited
South Ockendon
Essex RM15 5TD
(0708) 853444
telex: 897106 (3159M)

Step-by-step keyboarding on the personal computer

by Steven Radlauer
ISBN 0 8120 2628 4
256 pages; paperback £5.95

Computer users require more than powerful memory and a fast printer to get maximum production from their machines. They also need to be proficient at typing, getting information and instructions into the computer quickly and efficiently. Barron's new self-instruction book, *step-by-step keyboarding on the personal computer,* teaches how to increase typing output and thereby increase computer output.

All typing skills and special computer operations are taught one step at a time, then immediately strengthened through practice exercises and drills. Topics include word processing techniques, preparation of all types of business correspondence, editing and proofreading a text, and other essential skills. Numerous business applications are included, making the book particularly useful for upgrading office production. A special 'Word Processing Workbook' section contains 25 lessons with abundant instruction, practice, and drill material. In addition, the book includes an introduction to the important words and symbols of BASIC.

Esther Ewert Barron's
33 Sackville Street
London W1X 1DB
(01) 734 7282 (3152M)

Amstrad CPC464 explored

by John Braga

Seduced by glossy advertisements and favourable reviews you splash out on a CPC464 computer from Amstrad. By all reports, that would be a very sensible thing to do as the manufacturers seem to have got almost all their sums right with their first foray into the personal/small business computer market. Even the Amstrad manual is more informative than most. There comes a point, however, when you know the manual inside-out and start to think 'What next?'. You could do a lot worse than buy this recent publication from Kuma. The author assumes a reasonable knowledge of the computer's basic features and takes up where the manual ends. The book starts by looking at the machine's features but this is simply as an introduction to the remaining four parts of the book. These deal with the musical capabilities, graphics features, assembly language programming and a home accounting program as a demonstration of a serious application.

The book is written in a clear, readable style, with numerous examples to illustrate the features. Each section is dealt with in a methodical manner and some of the accompanying examples are very long. Instead of keying them in laboriously, however, you can buy two cassettes from Kuma and simply input the programs from them. The acid test of a book (or any review product for that matter) is the question of 'Would we buy it?'. The answer, in this case, is 'Probably!'.

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12 Horseshoe Park
Horseshoe Road
Pangbourne
Berkshire RG8 7JW
(07 357) 4335 (3151 M)

Iron stand leaves both hands free!

Tele-Production Tools are now manufacturing a stand for their 'stiron' range of heavy-duty soldering irons.

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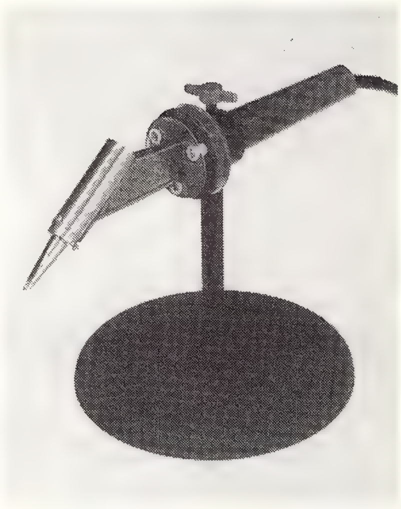
Any 'stiron' 875 series soldering iron in the range 60...200 W will fit into the stand: the operator can then use both hands in offering the work-piece to the iron for soldering.



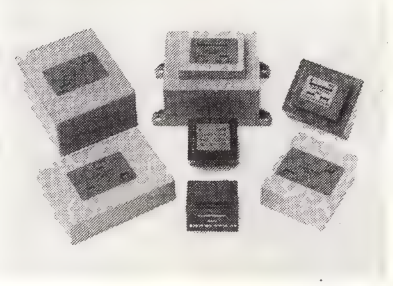
Tele-Production Tools Limited
Stiron House
Electric Avenue
Westcliff-on-Sea
Essex SS0 9NW
(0702) 352719 (3160M)

Miniature encapsulated transformers

With the introduction of twin voltage Low Profile Transformers and a range of miniature centre tapped 1.2 VA devices, Clairtronic now has the widest range of Encapsulated Mains Transformers in the UK. These designs are intended to avoid the most frequent cause of miniature transformer failings...handling damage to the exposed winding wire terminations. Encapsulation in polyurethene resin protects these fine wires and ensures reliability with good thermal conductivity.

The standard types are potted in square boxes with power outputs ranging from 1.2 VA to 50 VA in ten sizes. The Low Profile range covers 4 VA to 45 VA also in ten sizes with mounting heights from 17 mm to 49 mm.

The latest Low Profile Transformers have two primaries and dual outputs which meet the demand for multiple voltage devices for use in both North America and Europe. The twin primaries may be connected in series or parallel for use on 240 V or 120 V supplies.



All transformers are proof voltage tested to 4 kV r.m.s. (Low Profile units at 5 kV) and are designed to meet IEC742 (BS 3535) and CEE 15.

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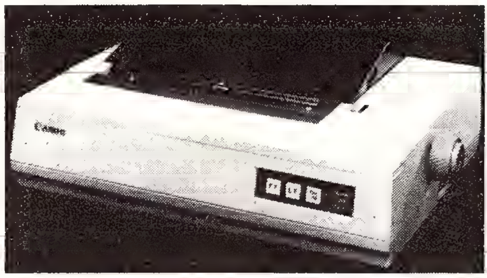

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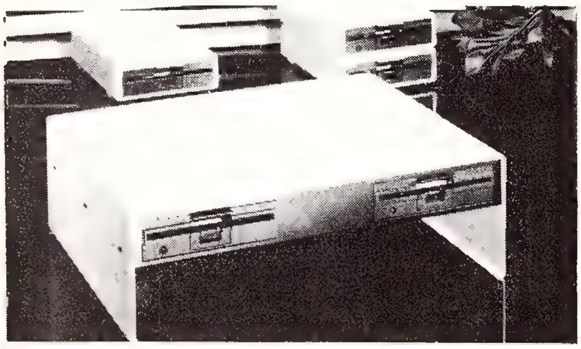

These drives are supplied ready cased with all the necessary cables formatting program and User Guide

There are some very useful utilities included on formating disc e.g.

- * DISASSEMBLER: This is 6502 machine code disassembler
- * DUP: To copy and rename a file on disc
- * FORMAT: Formating progam for 40 & 80 tracks
- * FREE: This utility provides a disk usage analysis
- * MDUMP: Enables you to display and modify any part of BBC memory
- * MERGE: Merge a number of text files into one file
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BBC 3: Same as System BBC2 but with 400K Drive
£875 + VAT = **£1006.25**

BBC 4: Same as System BBC 2 but with 400K Drive and JUKI 6100 Daisywheel Printer
£975 + VAT = **£1121.25.**

BBC 5: BBC Model B + Disk Interface, View (or Wordwise) Wordprocessor, 800K Dual Disk Drive (Mitsubishi), High Res Green Monitor, JUKI 6100 Daisywheel Printer, 1 Box (10) of 80 Track DS discs and all necessary cables £1145 + VAT = **£1316.75.**

SAN 1: Sanyo MBC 550 Series 16 Bit Microcomputer, 128K Ram, Dual 160K drives (2 x 160K), High Res Graphics (600 x 200 pixels in 8 colours), JUKI 6100 Daisywheel Printer, High Res Green Monitor, 1 Box of 10 discs, Wordstar Wordprocessor, Calcstar spreadsheet and all the necessary cables £1175 + VAT = **£1351.25**

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If you require High Res Colour Monitor instead of High Res Green Monitor in Sanyo Systems please add £320 + VAT = £368 to the above prices.

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P&P AS SHOWN IN BRACKETS (HEAVY ITEMS)
65p OTHERWISE (LIGHT ITEMS)

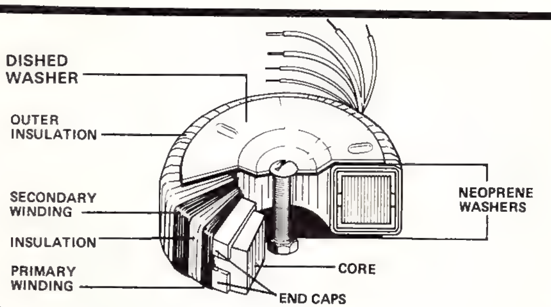
ADD 15% VAT TO TOTAL

ELECTRONIC COMPONENTS BOUGHT FOR CASH

TOROIDALS

The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 14 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.



15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1.25
0x011	9+9	0.83
0x012	12+12	0.63
0x013	15+15	0.50
0x014	18+18	0.42
0x015	22+22	0.34
0x016	25+25	0.30
0x017	30+30	0.25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

SERIES No	SECONDARY Volts	RMS Current
1x010	6+6	2.50
1x011	9+9	1.66
1x012	12+12	1.25
1x013	15+15	1.00
1x014	18+18	0.83
1x015	22+22	0.68
1x016	25+25	0.60
1x017	30+30	0.50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

SERIES No	SECONDARY Volts	RMS Current
2x010	6+6	4.16
2x011	9+9	2.77
2x012	12+12	2.08
2x013	15+15	1.66
2x014	18+18	1.38
2x015	22+22	1.13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0.45
2x029	220	0.22
2x030	240	0.20

80 VA
90 x 30mm 1Kg
Regulation 12%

SERIES No	SECONDARY Volts	RMS Current
3x010	6+6	6.64
3x011	9+9	4.44
3x012	12+12	3.33
3x013	15+15	2.66
3x014	18+18	2.22
3x015	22+22	1.81
3x016	25+25	1.60
3x017	30+30	1.33
3x028	110	0.72
3x029	220	0.36
3x030	240	0.33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

SERIES No	SECONDARY Volts	RMS Current
4x010	6+6	10.00
4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2.40
4x017	30+30	2.00
4x018	35+35	1.71
4x028	110	1.09
4x029	220	0.54
4x030	240	0.50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

SERIES No	SECONDARY Volts	RMS Current
5x011	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4.44
5x015	22+22	3.63
5x016	25+25	3.20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1.45
5x029	220	0.72
5x030	240	0.66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

SERIES No	SECONDARY Volts	RMS Current
6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6.25
6x015	22+22	5.11
6x016	25+25	4.50
6x017	30+30	3.75
6x018	35+35	3.21
6x026	40+40	2.81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0.93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

SERIES No	SECONDARY Volts	RMS Current
7x013	15+15	10.00
7x014	18+18	8.33
7x015	22+22	6.82
7x016	25+25	6.00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3.75
7x025	45+45	3.33
7x033	50+50	3.00
7x028	110	2.72
7x029	220	1.36
7x030	240	1.25

500 VA
140 x 60mm 4Kg
Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7.14
8x026	40+40	6.25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4.54
8x029	220	2.27
8x030	240	2.08

625 VA
140 x 75mm 5Kg
Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
9x017	30+30	10.41
9x018	35+35	8.92
9x026	40+40	7.81
9x025	45+45	6.94
9x033	50+50	6.25
9x042	55+55	5.68
9x028	110	5.68
9x029	220	2.84
9x030	240	2.60

Why a Toroid?

- * Smaller size & weight to meet modern 'slimline' requirements.
- * Low electrically induced noise demanded by compact equipment.
- * High efficiency enabling conservative rating whilst maintaining size advantages.
- * Lower operating temperature.

Why ILP?

- * Ex stock delivery for standard 240 V range
- * Fast prototype service available
- * 3 weeks despatch for special orders.
- * 2 year no quibble guarantee
- * No price penalty for call-off orders

Prices including P & P and VAT

VA	Size	£	VA	Size	£
15	0	7.06	160	5	12.17
30	1	7.67	225	6	13.75
50	2	8.90	300	7	14.97
80	3	10.06	500	8	19.60
120	4	10.65	625	9	22.30

For 110V primary insert "0" in place of "X" in type number.
For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.
IMPORTANT: Regulation - All voltages quoted are FULL LOAD.
Please add regulation figure to secondary voltage to obtain off load voltage.

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ILP ELECTRONICS LTD.

What the competition hasn't been waiting for.

Skywave
SOFTWARE
MULTI-FORTH 83
for ©
BBC
Micro
atest version of Forth for the BBC
s not rehashed Forth 79 Code)
nique Stack Display Utility
16k Eprom type 27128
Multi-tasking operating system for Real-Time use.

Here's the Forth Eprom for the BBC Micro that makes all others ut of date.

It's Multi-Forth 83 from David Husband who has built his eputation for Quality Forth products with his ZX81-Forth ROM, pectrum Forth-I/O Cartridge and now New Multi-Forth 83 for the BBC licro. This is not rehashed Forth 79 Code, but a completely new ersion of the Forth 83 Standard. It's unique in that it Multi-tasks, and ierefore the user can have a number of Forth programs executing multaneously and transparently of each other.

Multi-Forth 83 sits in the sideways ROM area of the BBC along ith any other ROMs in use. It is compatible with the MOS, and pecially vectored to enable a system to be reconfigured. It contains a andard 6502 Assembler, a Standard Screen Editor, and a Unique ack Display Utility.

With this Forth, David Husband has provided the BBC Micro with apabilities never before realised. And being 16K rather than 8K is vice the size of other versions. Multi-Forth 83 is supplied with an extensive Manual (170 pages plus) and at £45+VAT it is superb value.

Order it using the coupon adding £3.45 p&p (£6 for Europe, £12 outside) or if you want more information, tick that box instead. Either way, it will put you one step ahead of the competition.

Please send me Multi-Forth 83 for BBC Micro £45+VAT De-luxe System inc Disc £80+VAT
Cheques to Skywave Software Readers' A/C (or enter Visa No)

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Address____________________________
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Please send me more information
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☐ ZX81-Forth ROM
☐ Spectrum Forth-I/O Cartridge

SUBJECT TO AVAILABILITY FOR I.O.O.S ONWARDS
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BH1 4PW, Dorset, England Tel. (0202) 302385

Skywave SOFTWARE

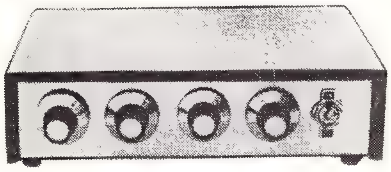
MULTI-FORTH 83 FOR THE BBC MICRO

BAKERS DOZEN PARCELS £1 each order 12 you get one extra free

25 – 1 of each wafer switches – 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 – 2 tape deck counters
27 – 1 6 digit counter 12v
28 – 1 6 digit counter mains voltage
29 – 1 BOAC in flight stereo unit (second hand)
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aerosol cans of ICI Dry Lubricant
34 – 96 x 1 metre lengths colour-coded connecting wires
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – Long and Medium wave tuner kit
40 – 4 x 465 KC IF transformers
41 – 8 Rocker Switches 10 amp Mains SPST
42 – 6 Rocker Switches 10 amp Mains SPDT
43 – 5 Rocker Switches 10 amp SP DT Centre Off
44 – 4 Rocker Switches 10 amp DPDT
45 – 1 24 hour time switch mains operated
46 – 1 6 hour clockwork timeswitch
47 – 2 lever switches 4 pole changeover up and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12v DC or 24V AC 4C0 relays
51 – 1 x 12v 2C 0 very sensitive relay
52 – 1 x 12v 4C 0 relay
53 – 2 mains operated relays 3 x 8 amp changeovers (secondhand)
54 – 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 – 1 locking mechanism with 2 keys)
56 – Miniature Uniselector with circuit for electric jigsaw puzzle
57 – 5 Dolls' House switches
58 – 2 telephone hand sets incorporating ear piece and mike (p)
59 – 2 flat solenoids – ideal to make current transformer etc.
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 earpieces
63 – 1 Mullard Thyristor trigger and modules
64 – 10 assorted knobs ¼ spindles

With most items quantity buyers get good discounts and save on postage costs.

SOUND TO LIGHT UNIT



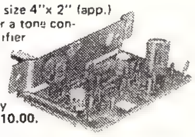
Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is **£14.95** in kit form or **£25.00** assembled and tested.

WANT A PART OF HISTORY? During the last war, cars and army lorries were able to travel without lights. The drivers looked through binoculars which contained infra red Converter Cells (a British invention). We have these infra red binoculars and you can obtain this bit of history for only £3.50 + £2.50 pp (Cases are a bit rusty through long storage and although unused, we cannot guarantee the cells are in working order, but working cells available.

THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses, appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 – 100 C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around **£15.00** – however, you can have the parcel for **£2.50.**

MINI MONO AMP on p.c.b., size 4"x 2" (app.)



Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 10 for £10.00.**

– BARGAIN OF THE YEAR –

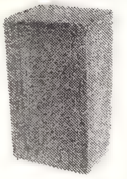
The AMSTRAD Stereo Tuner.

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio – easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are. long wave band 115 – 270 KHz, medium wave band 525 – 1650KHz. FM band 87 – 108MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board

Offered at a fraction of its cost: only £6.00
+ £1.50 post + insurance.



25w SPEAKER SYSTEMS

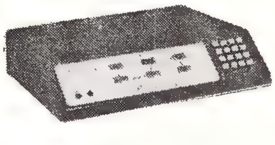
By Amstrad

25 watt RMS loading 8" woofer, 4" tweeter with crossover. £12.00 per pair + £4 post. New and unused but cabinets slightly damaged hence this low price, carry our normal guarantee.

CAR STARTER/CHARGER KIT Flat Battery! Don't worry you will start your car in a few minutes with this unit - 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 transformer only £12.50.

4/5A BATTERY CHARGER Transformer and rectifier £3.95 & £1 post, 3 kits £12 post paid.

PRESTEL UNITS

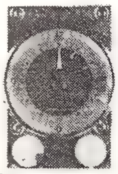


These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) – Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% – load regulation 1% from no load to full load – or full load to no load. Complete in heavy duty case – Models available: 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

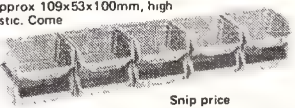
25A ELECTRICAL PROGRAMMER



Learn in your sleep: Have radio playing and kettle boiling as you wake – switch on lights to ward off intruders – have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at **£2.50.**

THIS MONTH'S SNIP

MULTI PURPOSE BINS

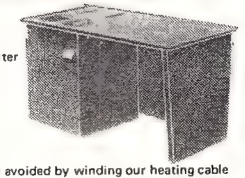


10 interlocking bins can be wall or bench mounted, each size approx 109x53x100mm, high impact plastic. Come complete with 2 wall mounting bars

Snip price £2.95 + £1.50 post.

3 lots £10 post paid

COMPUTER DESKS



Again available Computer desks – size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 – you must collect – hundreds supplied to schools.

FROZEN PIPES. Can be avoided by winding our heating cable around them – 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price 28p/metre or 15m for **£3.95**

FLEXIBLE EXTENSION LEAD twin rubber 5mm ideal grass cutter etc. 250 mtre **£25.50** metre coil **£6.75.**

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, 90% are unused componants.

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows

1 Framco motor with gear box
1 manual reversing & on/off switch
1 push to start switch
2 limit stop switches
1 circuit diag. of connections

£19.50 plus postage £2.50

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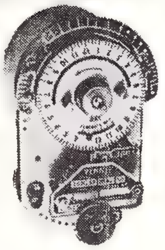
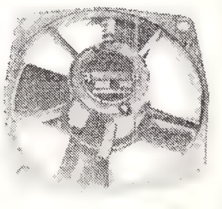
MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £12 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. **Bulk orders:** phone for quote. Shop open 9.00 – 5.30, Mon to Fri, not Saturday.



VENNER TIME SWITCH

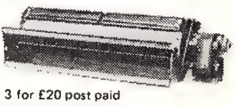
Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95.** without case, metal case - **£2.95**, adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.**
Ex-Electricity Board.
Guaranteed 12 months.

EXTRACTOR FANS – MAINS OPERATED



Woods extractor
5" - £5.75, Post £1 25
6" - £6.95, Post £1.25.
5" Plannair extractor
£6.50 Post £1.25.
4"x 4" Muffin 115v.
£4.50. 230v
£5:75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made
£11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed
£4.60. Post £1.50.

TANGENTIAL BLOW HEATER



by British Solartron, as used in best blow heaters. **3Kw £6.95** complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £20 post paid

2.5 Kw KIT Still available: **£4.95 + £1.50 post.** or have 3 for £16 post paid

ROCKER SWITCHES Standard size fit 11.5 x 28 mm cut out. Single pole on/off – 15p each 1000 for £75. Single pole changeover 20p each – 1000 for £100. Single pole changeover with centre off – 25p each – 1000 for £125. Single pole on/off with neon – 36p – 1000 for £180.

ROCKER SWITCH DP/DT 15 amp 250 volts suitable for motor reversing etc. – 46p – 100 for £34.50, 1000 for £230.

MICRO SWITCHES V3 type all 250 10 amp SpST 20p 1000 – £100 Spdt 30p 1000 – £150, very low tongue Spdt 40p 1000 for £200.

TOP OF THE POPS LIGHTING

if you use our disco switch These have 9 x 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc etc. 230 volts mains operation, £5.75 each or 10 for £50. VAT included.

WALL MOUNTING ROOM THERMOSTAT

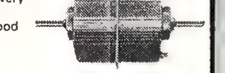
By Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0 – 30 c – 13 amp 250v contacts. Price £4.60. – 10 for £40.

BLEEPERS 6 or 12v battery or transformer operated, ideal for using in alarm circuits but particularly suitable for can and motor cycle alarms. These give a loud shrill note. Price 69p. 1000 for £345. Jap made.

MINIATURE WAFER SWITCHES

2 pole, 2 way – 4 pole, 2 way - 3 pole, 3 way - 4 pole, 3 way – 2 pole, 4 way – 3 pole, 4 way – 2 pole, 6 way – 1 pole, 12 way.
All at 25p each or 10 for £2.00

12 volt MOTOR BY SMITHS



Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle –
Price £3.45.
Ditto, but double ended **£4.25.**

MAINS MOTORS

We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included.

£11.95 plus £2.00 post.

OTHER POPULAR PROJECTS

R C Bridge Kit	£9.95
3 Channel Sound to Light – with fully prepared metal case	£14.95
Big Ear, listen through walls	£9.50
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch – fools friends and enemies alike	£1.95
3 - 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Radio stethoscope – fault finding aid	£4.80
Mug stop – emits piercing squark	£2.50
Morse Trainer – complete with key	£2.99
Drill control kit	£3.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
F M receiver kit – for surveillance or normal F M	£3.50
Insulation Tester – electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio – receives Medium Wave	£2.95
40 watt amp – hifi 20hz – 20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8 50

elektor switchboard

48k SPECTRUM for sale, complete with recorder and over 25 software programs, and numerous magazine articles — £100 o.n.o. Adrian Snow, 103 Abbey Road, Macclesfield, Cheshire SK10 3PA. Tel. 21359.

VANTED: BC 258 transistors. Telephone Harpenden (05827) 52540.

VANTED: ½" TAPE DRIVE, 9 rack, which I could possibly conect to my micro. will pay up to 100 for good one. Tel. 0274 35809.

UAL BEAM oscilloscope, £95. C volts standard, £35. ± 12 V 0 A P.S.U. £5, 2 A Variac, £5. 22 irch Dale, Hythe, Southampton.

NFORMATION required for makng positive photo resist compound make PCB's photo-sensitive. Will end gift to helper. Iftikhar Ahmad H, P616-A Angatpura, Rawalpindi, akistan.

VANTED: HP64000 Series equipent. Please ring Southampton 703) 760696 with details.

ell SERVICE MANUALS for copes; Tektronix 535/545 £9; Teleuipment D52/S52 £4; Solartron D523S £4; Heathkit SB610 £6. Mr. . Small, 8 Cherry Tree Road, hinnor, Oxon. OX9 4QY.

OMPLETE SET of Elektor, mint, binders, £65, with UK postage. tevenson, 44 Queens Road, ethersett, Norfolk.

ANTED — Sony black & white deo camera, type HVM-100CE, in ood working condition. Tel. 0705 3400 evenings & weekends.

NVERTER Sinewave 120 W 12 V C to 220 AC, Valradio make, in ome made case, £48. Tel. 023 618 (North Devon).

Sell RECEIVER MANUALS: R1155, £9.70; CR100, £10.60; lots of others. SAE enquiries to Mr Small, 8 cherry Tree Road, Chinnor, Oxon. OX9 4QY.

BBC B + DFS + 100K disc drive + 10 disks + £100 value in books and software, £600. Also a Microvitec RGB VDU, £180. Tel. 01 348 6401 evenings.

SWAP my Trend Telegraph and data Signal Analyser type 1 for 20 MHz Dual Trace Scope with delay. Tel. Bill, 0908 368761.

7-SEG. LED displays, high intensity, 75p; Relays, 6 V 4-pole c/o, 5 A rated, £2; WANTED — Nascom 2 graphics ROM. Tel. 0375 674089.

I am 17 years old, French, and looking for English penfriend to swap various information on electronics. Write me, Mazurien Damien, La croix des Ardilliers, 50380 St. Pair, France.

REVOX B77 Hi Speed with lots of tapes, and dust cover, mint condition — £450 the lot. Call Gerry — day 01 629 3758, evenings 01 504 6398, Ilford area.

6809E £4; 74LS783 £4; 10+ mix £35; 783 data £3; Cap's 2.2μ 16V 100/£1; Ferrite trans. 15:39 turns 20/£1. P&P 25p. Nic Spiers, 114 Greenway, Tunbridge Wells, Kent TN2 3JN.

FOR SALE: Programs for 48k Spectrum to design parabolic dishes or 3-element beams. Both progs. use printer. £4.50 each. D. Butler, "Hillview", Ardattin, Co. Carlow, S. Ireland.

TEKTRONIX 581 24 MHz Dual Trace, £120. Tek Curve Tracer, £85. Tek Plug-in Type D, £15; G, £35; DG Nova 3 Minicomputer, £675. Phone T. Haley, 01 868 4221.

ELEKTOR back copies from no. 89 to 114 inclusive, for sale. Offers please, to G. Spencer, 40 Sunfield Lane, Diggle, Oldham, Lancs, OL3 5PT. Tel. Saddleworth 71222.

TV GAMES COMPUTER freaks! I am looking for penfriends to exchange programs and ideas. C. Turner, 120, Morley Hill, Enfield, Middlesex EN2 0BG.

WANTED — any information on CMC Terminal/VDU type/serial 1015. 60 way ribbon cable, £1 per metre — SAE for sample. D.C. Pooley, 27 Firs Orchard, Bromyard, Herefordshire HR7 4BB.

I am looking for a penfriend interested in electronics. Also would appreciate information on electronics publications. Amir Ghavam, No. 5, Golegandom Alley, Dr. Hooshiar St., Azadi Ave., Tehran 13419, Iran.

I am interested in writing to Elektor readers in Germany, Holland, or Sweden. Please reply in English to: Mr P.A. Morris, 107, Rydes Hill Road, Guildford, Surrey, England.

OPTICAL ENCODER discs 32 bar 4 cm, 2 for 450p; 12 V Stepper Motors with gearbox, 1250p; Accelerometers ± 35G, £10; Video CCDS, £30. Peter Silver, 18 Acacia Road, Hampton, Middx. Tel. 01 979 6129.

I NEED to buy L.S.I.AY-3-8710 for £20. Please write to Abbas Rezaei, P.O. Box 62, Najafabad-Isfahan, Iran.

MEMORIES, 8 off HM6116LP-3 (2K × 8 bit), £30. New, surplus to requirements. Tel. 0302 22099, evenings or weekends.

INFO wanted for EPROM programmer using ZX81 Ccts. and software. Willing to buy or exchange Bit and pieces. Mr. F.J. McDonald, 55 Dunn Road, Peterlee, Co. Durham SR8 5JG.

JUNIOR COMPUTER interface board wanted, working or not, or just PCB. Mr N. Woodward, 242 St. Johns Road, Walthamstow, London E17 4JW.

COMPONENTS: large and varied private stock for sale. All items are high grade prof. standard. Send SAE or phone. W.I.A. Murray, 80 Ashley Terrace, Edinburgh EH11 1RT. Phone 031 337 5968.

I'M INTERESTED in computers. I have a Dragon 32. Other Dragon users please write to me. Jyri Ahonen, Surumäki, 59100 Parikkala, Finland.

WANTED — 80 BUS/NAS-BUS boards, e.g. RAM, I/O, A/D, etc. Tel. 01 977 8305.

FREE advertising for our readers!

ules:

Private advertisers only. No trade, no business.

Full address or private telephone number; no post office boxes.

Items related to electronics only. Software only when related to Elektor computer stems.

Maximum length: 114 characters — letter, numeral, comma, space. etc. (not cluding address and/or telephone number).

One advertisement per reader per month. To enforce this rule, a switchboard voucher ll be printed each month.

Elektor cannot accept responsibility for any correspondence or transaction as a sult of a 'switchboard' ad, nor as a result any inaccuracy in the text.

Ads will be placed in the order in which they are received.

We reserve the right to refuse advertisements, without returning them.

I am a private reader. I have read your rules and I enclose a valid switchboard voucher. Please place the following advertisement, free, in the next available space.

BLOCK CAPITALS PLEASE — ONE CHARACTER TO EACH BOX

Name and address:

Send to:

Elektor switchboard,
Elektor House
10 Longport
Canterbury CT1 1PE

All advertisements *must* include the voucher printed here. They must be post-marked within the month indicated.

elektor switchboard MARCH '85

Appointments

Appointments Vacant display advertisements: rates available on request from Elektor Publishers Ltd., 10 Longport, Canterbury, Kent CT1 1PE. Phone Canterbury (0227) 454439.

ELECTRONIC ENGINEERING VACANCIES

We have a large selection of vacancies within London and the home counties — here are just a few from our extensive register.

TEST ENGINEERS — all levels, Essex — £9000+
ANALOGUE DIGITAL TESTERS — Middlesex — £8200
BUYER (ELECTRO MECH.) — Herts. £10,000 neg.
ELECTRO MECH. DESIGN DRAUGHTSMAN — Watford — £11,000 neg.
ELECTRONICS DESIGN ENGINEER — Herts. — £ excellent
ATE DESIGNER — communications — £12,000

We also have a good number of contract positions — please telephone for details.

May Maguire,
STAFFHIRE
STAFFHIRE LIMITED, 80 High Street, WARE, Herts, SG12 9 AV.
Telephone 0920-5921.

SALES AND MARKETING

DEALER SALES MANAGER — **£16k + car + Comm.**

A senior position with responsibility for sales of modems and network products across the UK and Europe. A range of duties include dealer management, technical liaison, product monitoring etc. A degree in an appropriate subject as well as previous sales experience will give you the chance to grasp this career opportunity.

PRODUCT MARKETING MANAGER — **to £ 14k**

A leader in computer communications with a professional marketing philosophy would be interested to talk to experienced analysts from a like background to seek out new products. No man-management but good communications skills are essential as there will be close liaison required within the company.

PRODUCT MANAGER — **£Negotiable**

An expanding agent in the electronic component and equipment fields, seeks a qualified engineer/sales person/marketeer to adopt and control the franchise operations. The company, an award winner, provides a technical service to its customers and your hi-tech background and verbal and personal presentation should enhance this reputation.

DESIGN/SALES ENGINEER — **c£12k + car**

The company is a famous manufacturer in the consumer and industrial electronic markets. It now needs an engineer who can both sell a technical service and design single chip technology to customers specifications. Languages would be useful for a position with excellent career prospects in an expanding division.

For further details contact James Hay at the address below.

TECHNICAL

MANAGER — COMMUNICATIONS AND STRATEGY — **£25k + car**

As a major multi-national leading the world in integrated office automation, my Client is firmly committed to expanding their office and systems automation group.

As part of this planned growth, they wish to recruit a key member for their management team. The successful candidate will be responsible for developing and maintaining an engineering position on communication strategies, in particular, that for worldwide engineering and marketing groups.

The individual will be appointed Manager of a specialist group that will form the centre of expertise in "comunications" for the various product areas and will have significant input to marketing proposals for new systems developments.

PROJECT ENGINEER — **c£14k**

An established automated controls manufacturer requires an electronics specialist to develop mini/micro computer based systems from concept to final installation. The engineer will provide technical support to the marketing function and control projects through the design/prototype phases. A background in hard/software development essential.

DESIGN ENGINEER — **c£12k**

A major computer communications manufacturer requires a network designer to control a team of graduates involved in new product research. It is good opportunity to gain exposure to State of the Art technology plus having the backing of a substantial R & D budget.

For further details contact Stephen Salt at the address below.

Management Personnel
Recruitment Selection & Search
2 Eton Court, Eton, Windsor, Berkshire.
Telephone: (07535) 54256

Michael Stevens & Partners

PROJECT ENGINEER▪NEGOTIABLE SALARY.

Michael Stevens and Partners, a rapidly expanding company based in Bromley, designs, constructs and supplies specialist audio and video equipment for recording studios, broadcast companies, cable TV operators and other professional clients.

A project engineer is now urgently required to join the design and production team of this lively company. Candidates should be suitably qualified in electronics to HNC/HND standard, although practical aptitude and initiative are more important and applications are welcomed from individuals who have gained experience in the design and construction of electronic equipment through commercial involvement or as an enthusiast pursuing an active interest in this field.

This is an excellent opportunity to join a successful team working in one of todays most exciting industries. Please write or telephone for an application form to:

Michael Stevens & Partners
The Homesdale Centre, 216-218 Homesdale Road,
Bromley Kent BR1 2QZ
Phone 01-460 7299

EDITORIAL ASSISTANT

We require an editorial assistant for our English-language office in the southern Netherlands for the preparation of technical books and magazines. The person appointed must be a native English speaker, thoroughly familiar with practical electronics, and be capable of translating technical material from Dutch (and preferably French) into English. Write, giving full details of experience and qualifications, to Mr A.J. Brialey

Elektor Publishers Limited
10 Longport
Canterbury CT1 1PE
Kent

ecm

THE BEST APPROACH

£7,000-£30,000 + CAR

★ **Where does your interest lie:** Graphics; CAD; Robotics; Simulation; Image and Signal Processing; Medical; Automation; Avionics; Acoustics; Weapons; Comms; Radar; Opto and Laser?

★ **Experienced in:** VLSI; Microprocessor Hardware or Software; Digital and Analogue circuitry; RF and Microwave techniques?

★ **There are hundreds of opportunities in:** Design; Test; Sales and Service for Engineers and Managers

★ **For free professional guidance:** Call 0638 742244 (till 8pm most evenings) or write (no stamp needed) to:

ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
FREEPOST, The Maltings, Burwell, Cambridge. CB5 8BR.

Appointments

Appointments Vacant display advertisements: rates available on request from Elektor Publishers Ltd., 10 Longport, Canterbury, Kent CT1 1PE. Phone Canterbury (0227) 454439.

ELECTRONICS/COMPUTERS

* Do you have a sound knowledge of electronics, computer hardware or software, acquired from formal education, job experience or as a serious leisure activity?

* Are you interested in becoming involved with some of the latest 'state-of-the-art' technology in one or more of these fields?

* Do you have the ability to express yourself clearly and concisely in the written word?

If you answered 'YES' to these three questions, you could find a career with ETP both challenging and rewarding.

Our company produces user manuals and technical handbooks, to a high standard, for a wide variety of products, from large electronics systems to software for personal computers. This involves liaison with our clients, developing a detailed understanding of the product, organising and writing the handbook and coordinating the production of the finished text and illustrations.

We currently require people to train as Technical Authors to produce this documentation. The company offers varied and interesting work, a pleasant working environment, free membership of BUPA and salary commensurate with your knowledge and experience.

Applications from prospective trainees and experienced Technical Authors to:

The Manager
Engineering & Technical Publications Ltd.,
12 Shute End, Wokingham, Berkshire RG11 1BJ.
Tel. Wokingham (0734) 790123

MOVING?

SUBSCRIBERS' change of address coupon-mail to Elektor Publishers Ltd., 10 Longport, Canterbury, Kent CT1 1PE, U.K.

Please attach magazine label here, list new address below, and mail six to eight weeks before you move. If you are receiving duplicate copies of Elektor, please send both labels.

Surname

Initials

Street/Ave./Blvd.

Town

County/Province/State

Post code/Zip/Area code

Country

RECRUITMENT

We have been successful in filling both senior and junior vacancies from our comprehensive file of applicants who have registered with this Company. We now wish to extend our file to meet future demands and are seeking application for registration mainly from those whose qualifications and experience fall in the following categories:

Management staff with engineering qualifications and experience in Television and Radio broadcasting or related technologies.

Transmitter installation or operations and maintenance engineers and technicians for Broadcasting and Telecommunications services.

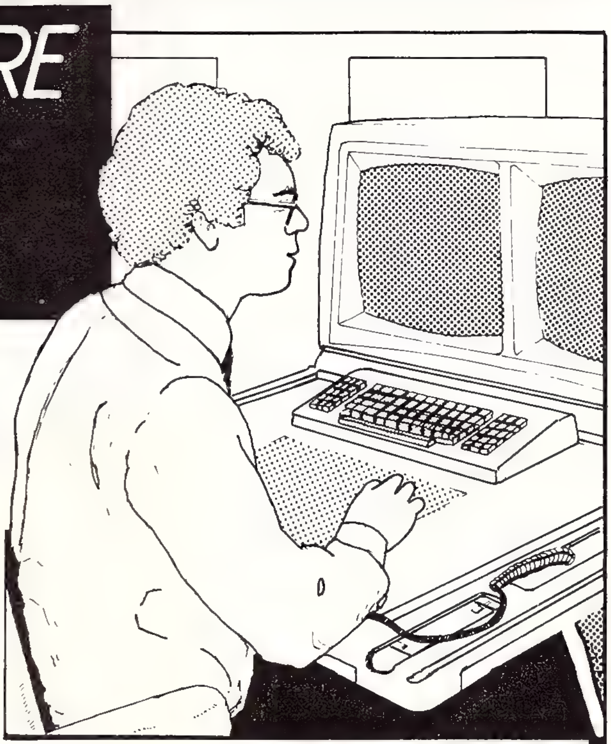
Television Studio and Outside Broadcast engineers and technicians.

Graduates with Electronics degree but without material practical experience.

Vacancies occur both for U.K. based and overseas posts.

If you believe your skills or qualifications meet the above broad requirements please contact:

PERSONNEL & ELECTRONICS LTD.
Triumph House 1096 Uxbridge Road Hayes Middlesex UB4 8QH England U.K.
Telephone: 01-573 8333 Telex: 934271



HIGH CALIBRE DESIGN ENGINEERS

Various Locations – c£7,000 - £13,000

We currently have a requirement, on behalf of a number of client companies, for experienced Design Engineers to fill vacancies in the following areas:-

AUTOMOTIVE

Engine/Power Units

- Engine Components (Petrol and Diesel).
- Engine Ancilliaries - Fuelling systems. Turbochargers.

Transmissions

- Transmission Systems.
- Driveline/Axles/Drive Shafts.
- Gear Design.

Chassis

- Suspension Systems.
- Steering.
- Braking Systems.

Vehicle Electrics

- Electronic Ignition/Fuelling Systems.
- Advanced Instruments/Driver Information Systems.
- Multiplex Wiring.

GENERAL

Electronics

- PCB Design.
- Analogue/Digital Circuitry.
- Systems Engineering plus Software Design (FORTRAN, ASSEMBLER, BASIC AND CORAL).
- Micro Circuitry, thick and thin film design.
- Microprocessors/PLC Applications.

Stress Engineering

- Finite Element Analysis (Rotating and Structural Components) using any of the following packages NASTRAN/SUPERB/STRUDL/PAFEC/ANSYS.

Materials Engineering

- Composite Materials.
- Plastics and Polymers.
- Fracture Mechanics.

Ideally, candidates should be educated to HNC/Degree level, or equivalent, and possess 2/3 years relevant experience in one or more of the above disciplines. Hands-on CAD User experience would also be advantageous. So if you are an accomplished Designer who wishes to develop his/her career further, write with full career details (including salary), or telephone for an application form to Stephen Bailey:

JonathanLee Technical Recruitment

☎ (0384)
397555 (24 hrs.)

62 Hagley Road, Stourbridge,
West Midlands DY8 1QD.

Appointments

Appointments Vacant display advertisements: rates available on request from Elektor Publishers Ltd., 10 Longport, Canterbury, Kent CT1 1PE. Phone Canterbury (0227) 454439.

ADVANCE YOUR CAREER IN THE EXPANDING WORLD OF

Mobile Communications Systems

Hardware/Software & Systems Design

to £18,000 S.E. England

We are now able to offer you the opportunity to join one of the most prestigious companies addressing the new technology race in adaptable Mobile Communications Systems. A programme of rapid expansion and technical innovation has created a number of new career positions both in the development of New Advanced Communication Hardware and Software and in System Design and Configuration.

Hardware/Software Development

Vacancies exist at Project Leader, Section Leader and Design Engineer levels. You would be developing some of the most technically advanced portable, mobile and fixed station equipments. Specifically our client is seeking Engineers with experience in one or more of the following:-

RF Engineering (70-470 MHZ)
Assembler Software
Frequency Synthesisers /Phase Lock Loops
Microprocessors/ VLSI Technology

Systems Development

Establishment of a new department has created vacancies for Communications Systems Engineers at all levels to design Integrated Mobile Systems for major users including transport (with the special challenge of rail communications) public and emergency services as well as private users. You would have full project responsibility, working in close liaison with the client's staff to plan, design and implement some of the most challenging and sophisticated communications networks. In particular, our client seeks Engineers with experience in any of the following areas:-

VHF/UHF Radio Systems
Microprocessor Systems
Analogue/ Digital Design

Our client's approach to design and development reflects the vibrant commercial environment in the Mobile Communications market and their search for top flight Engineers is backed by investment in some of the best design facilities including full VAX based simulation facilities.

You will be joining a company which has one of the most respected names in communications engineering and is able to demonstrate both the ability to continually expand and innovate and also to provide a real opportunity for personal career development. Situated in South East England with easy access both to unspoilt countryside and more sophisticated amenities, our client is able to offer first-class salaries and a full company benefits package.

To discover more about these important new opportunities and to obtain an early interview please telephone FRED JEFFRIES C.Eng. MIERE in complete confidence on Hemel Hempstead (0442) 47311 during office hours or our duty consultant on Hemel Hempstead (0442) 212650 evenings or weekends. Alternatively write to him at the address below.

Executive Recruitment Services
THE INTERNATIONAL SPECIALISTS IN RECRUITMENT FOR THE ELECTRONICS COMPUTING AND DEFENCE INDUSTRIES
25-33 Bridge Street, Hemel Hempstead, Herts., HP1 1EG.

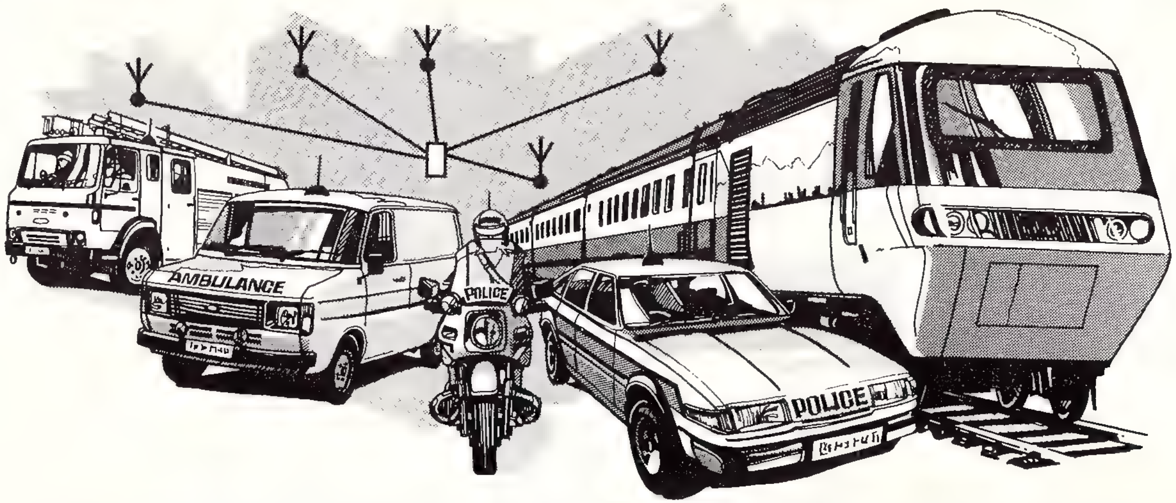
MICROWAVE SPECIALISTS £14,000

Our client designs and manufactures a comprehensive range of microwave components including Diodes, Transistors, MIC components and Subsystems.
Products range from 10 MHz to 100 GHz, in ECM, Radar & communications systems.
Their in-house capabilities are second to none in solid state device & thick film technology. The latest CAD and ATE techniques are used to produce a wide range of microwave and millimetre wave components.
The microwave capability includes the development of a wide range of Ferrite and Dielectric materials designed for a variety of high frequency applications.
The company have a remarkable growth record and, though still a young organisation, reap the advantages of being part of a successful public group.
Salary, benefits and relocation packages are of the most competitive nature.
The location is attractive and offers an excellent 'Quality of life' to single or married candidates.

To discuss this position in detail telephone Jacqueline Squires, Consultant, on Lewes (0273) 471271 'til 8 pm.

The Electronics Recruitment Company
E.R.C. House, 32-33 North Street, Lewes, East Sussex BN7 2PQ. Tel. Lewes (0273) 471271

JOIN IN OUR EXPANSION



DEVELOPING THE MOBILE RADIO NETWORKS OF TOMORROW

With the phenomenal growth of our business Marconi Mobile Radio are entering a new phase of an ambitious expansion programme. Our recent successes have resulted in the creation of a new department to provide mobile communication control systems for major users including transport, public utilities and emergency services.

SYSTEMS DEVELOPMENT ENGINEERS

For new exciting projects, including train communications systems, we require experienced Systems Development Engineers to lead our expanding teams.

As a key member of one of these highly professional teams you will be involved in the planning and hardware design of mobile radio control systems for VHF, UHF, fixed and mobile equipment incorporating microprocessors and VLSI techniques.

Opportunities exist at several levels for Systems Engineers with the capability to provide novel, practical solutions to satisfy the complex operational requirements of large scale networks.

Senior positions will also involve project responsibility for system design, test and installation; the preparation of engineering estimates; project planning and the supervision of a team of engineers.

Candidates should possess at least 2 years system development experience, preferably radio based, together with a good knowledge of analogue and digital techniques. Familiarity with microprocessors and telephony practice would be an added advantage.

So if you would like to join a rapidly expanding company and work on advanced radio communications technology get in touch with us now.

We offer excellent career prospects with salaries of up to £15k and attractive benefits including assistance with relocation where appropriate.

Write with details of your experience or phone for an informal discussion to Gordon Short, Marconi Communication Systems Limited, New Street. Chelmsford, Essex, CM1 1PL. Telephone: Chelmsford 353221, ext. 3598.

Marconi
Communication Systems

Marconi

service

Elektor printed-circuit boards, front panels, and software are obtainable from our Canterbury office. Software may also be ordered from Technomatic Limited.

When ordering, please use the order card provided at the end of this issue and state the issue number, or month of publication, of the magazine, the title of the article, and the number of the board, front panel, or software item. Please allow 6/8 weeks for delivery.

Prices in sterling include 15 per cent value added tax, and should be increased by 55p (UK only) or £ 1.10 (other countries, except the USA) for postage and packing.

Prices in dollars are exclusive of any taxes, and include postage & packing for surface mail. If airmail is required, please add $ 1.50.

SUBSCRIPTION SERVICE

January to December incl. (See also Subscription Order Card towards the end of this issue).

United Kingdom		£11.50
USA/Canada	surface mail	$31.00
	airmail	$57.00
Other countries	surface mail	£13.50
	airmail	£27.00

TECHNICAL QUERIES SERVICE

This service is intended to assist readers who experience difficulties in the construction of Elektor projects. All queries should be submitted in writing to our Canterbury office. To help us in being able to send you a quick reply to your letter, we would ask you to observe the following points.

- Your letter should include a stamped self-addressed envelope or, if you live outside the United Kingdom, an International Reply Coupon.
- State at the top left-hand corner of the envelope the code 'TQ' and the subject of your letter.
- We regret that we can only respond to queries relating to Elektor projects published within the last three years. This applies also to queries by telephone.
- It would be appreciated if you could state your query as briefly as possible, and give information on measured voltages, currents, components used, and use capital letters where necessary (as in technical expressions, for instance).
- If certain components are not immediately available in your area, glance through the advertisements in this issue before phoning or writing to us. You'll be surprised how often you can find that elusive part.
- We regret that we cannot enter into correspondence regarding queries which are not directly related to published projects (such as adaptation of the designs to non-Elektor ones). This applies also to additional data on components and theoretical information on Elektor circuits. These exclusions have proved necessary to prevent a disproportionate amount of time being spent by our editorial staff in answering such queries.

SOFTWARE SERVICE

µP TV games on cassette	**No.**	**£**	**$**
15 programs: jackpot, reversie, amazone, code breaker, etc.	007	5.50	11.00
15 programs: invaders, fishing, maze adventure, memory, pontoon, nim, etc.	009	6.90	13.75
15 programs: aliens, flipper, helicopter, pilot, basketball, hangman etc.	010	6.90	13.75
15 programs: snakes & ladders, snap, mazes, break-out, horse races, cosmic adventure, Omega landing etc.	011	6.90	13.75
Software on EPROMS			
dark room computer ext. 1 x 2716 EPROM	514-N	8.40	16.75
DOS software 1 x 2708 EPROM	515	5.30	10.50
talking dice 1 x 2716 EPROM	516	8.40	16.75
ELEKTERMINAL + elekterminal 1 x 2716 EPROM	517	8.40	16.75
morse program for the Junior Computer 1 x 2716 EPROM	518	8.40	16.75
telex program for the Junior Computer 1 x 2716 EPROM	519	8.40	16.75
ASCII keysoft 1 x 2716 EPROM	520	8.40	16.75
character generator and video routines for DOS Junior 1 x 2732 + 1 x 2716 EPROMS	521	18.90	37.75
character generator and video routines for extended Junior 1 x 2732 + 2 x 2716 EPROMS	522	27.30	54.50
character generator 1 x 2732 EPROM	523	10.50	21.00
quantisizer 1 x 2716 EPROM	524	8.40	16.75
universal terminal 1 x 2732 EPROM	525	10.50	21.00
wind direction indicator 1 x 2716 EPROM	526	8.40	16.75
elabyrinth 1 x 2716 EPROM	527	8.40	16.75
EPROM copier 1 x 2716 EPROM	528	8.40	16.75
analytical video display 1 x 82S23 EPROM	529	10.50	21.00
typewriter interface 2 × 2716 EPROM	530	16.80	33.50
µP-controlled frequency meter 1 × 2732 EPROM	531	10.50	21.00

FRONT PANEL SERVICE

		£	$
Elektor Artist (E85)	82014-F	2.80	5.70
precision power supply (E92)	82178-F	2.50	5.00
Prelude (E94...E96)	83022-F	4.40	8.75
7-day timer/controller front panel including membrane switches	83041-F	13.10	26.25
Maestro	83051-F	4.90	9.75
capacitance meter	84012-F	5.20	10.50
real-time analyser	84024-F	7.80	15.50
direct-coupled modem	84031-F	4.50	9.00
pulse generator	84037-F	4.60	9.25
µP-controlled frequency meter	84097-F	10.50	21.00
function generator	84111-F	5.00	10.00

BACK NUMBER SERVICE

Only the back numbers listed below are currently available.

Price are as follows:

any one issue (except July/August)	£ 1.50
additional issues, each	£ 1.30
July/August (Summer Circuits)	£ 3.00

Prices include postage and packing. For overseas orders requiring airmail postage add £ 1.50 per issue (£ 2.00 for July/August).

1978: E34, February; E38, June.
1979: E54, October; E55, November.
1980: E58, February;
E65, September; E66, October; E67, November;
E68, December.
1981: E70, February; E72, April; E73, May;
E77, September.
1982: E89, September; E90, October; E91, November.
1983: E93, January; E94, February; E96, April;
E97, May; E99/100, July/August;
E101, September; E102, October;
E103, November; E104, December.
1984: E105, January; E106, February; E107, March;
E108, April; E109, May; E110, June;
E111/112 July/August; E113, September;
E114, October; E115, November; E116, December.
1985: E117, January; E118, February.

COPY SERVICE

Photocopies of articles can only be supplied from out-of-print back issues of Elektor. State details of the article required, and the number, or month of publication, of the back issue containing the article together with your name and address on the relevant order card at the back of this issue. Cost of any one article is £ 1.50 (incl. p&p). Cost of additional articles (ordered at the same time) is £ 1.30 (incl. p&p).

PRINTED CIRCUIT SERVICE

The following list shows the printed circuits pertaining to projects published within the last six months and which are currently available.

	No.	£	$
E114: OCTOBER 1984			
direct-coupled modem design	84031	17.85	35.75
ZX81 pulse cleaner	84075	4.50	9.00
RS232 centronix adapter	84078	6.60	12.25
video inverter	84084	4.05	8.0
dynamic pre-amplifier	84089	2.85	5.75
E115: NOVEMBER 1984			
burglar alarm	84088	2.70	5.50
valve amplifier	84095	6.30	12.50
autodim	84096	2.65	5.25
telephase	84100	2.50	5.00
TV as monitor	84101	2.70	5.50
mini printer	84106	7.45	15.00
E116: DECEMBER 1984			
time switch	84107	2.75	5.50
function generator	84111	8.15	16.25
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service

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		£	$
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E44: DECEMBER 1978			
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E53: SEPTEMBER 1979			
parametric equalizer			
tone control section	9897-2*	2.20	4.50
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E74: JUNE 1981			
Junior Computer			
-12 V supply	81033-2	1.90	3.75
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E77: SEPTEMBER 1981			
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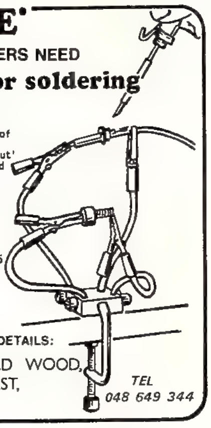

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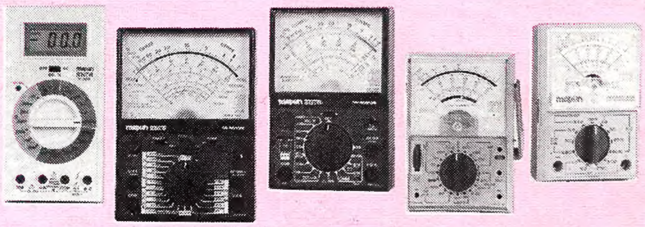

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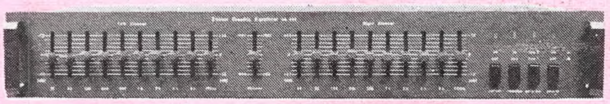

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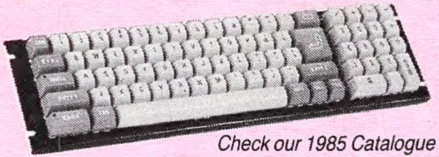

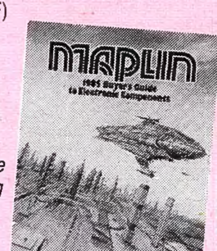

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